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The Impact of Occupant Behaviour on Passive Environmental Design Strategies in Heritage Buildings: A Case Study of San Anton Palace, Malta

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THE IMPACT OF OCCUPANT BEHAVIOUR ON PASSIVE ENVIRONMENTAL DESIGN STRATEGIES IN HERITAGE BUILDINGS: A CASE STUDY OF SAN ANTON PALACE, MALTA

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Candidate: Amber Wismayer

Declaration of authorship

I am the author of this thesis, and the work described therein was carried out by myself personally, with the exception of Section 7.4.2, where publications presented in Table 7.1 and Appendix E involve the collaboration and contribution of other researchers.

Candidate: Amber Wismayer

For my grandmother, Mary Victoria Mintoff

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Abstract

There is growing interest in the field of energy performance of heritage buildings. Mediterranean vernacular architecture incorporates passive environmental design strategies that have been shown to improve comfort and subsequently reduce energy demand. However, research has generally targeted technical solutions for energy efficiency. The subject of occupant perceptions and behaviour in heritage buildings has been largely neglected, despite acknowledgement of its potential in reducing energy demand.

This research examined the framework for designing and assessing interventions on vernacular architecture in Malta. It sought to identify core determinants that may support the sustainable regeneration of built heritage. It aimed to determine whether the inherent potential of passive environmental design strategies in the case study of San Anton Palace in Malta are being compromised.

Adopting a mixed-method approach, primarily comprising qualitative techniques, the study encompassed workshops, a questionnaire, a focus group, and a case analysis. It evaluated the perceptions and attitudes of stakeholders and building occupants and users[1].

The results demonstrate that, in addressing local architectural heritage, focus has been placed on aesthetic preservation of the built fabric, rather than the building dynamics. Robust value is not attributed to passive strategies, inherent to this typology, as a functional environmental control mechanism improving comfort. Although these features can effectively contribute to improving occupant comfort, and hence reduced energy demand, their potential is not being effectively utilised

The findings highlight areas of priority in:

- the national systems and educational framework targeting public awareness and stakeholders' knowledge base surrounding passive environmental design strategies in heritage buildings; and
- the regulatory framework designed to assess interventions on heritage buildings.

The main contributions to knowledge are summarised as follows:

1. The study provided an understanding of the inherent potential offered by passive environmental design strategies at San Anton Palace, Attard, highlighting the ways in which the potential is being compromised; and putting forward recommendations on how the potential may be maximised. In doing so, a pre-design intervention assessment methodology for large-scale, mixed-use heritage buildings has been developed and validated. The methodology:

   - outlines pertinent parameters to be investigated;
   - focuses on proactively and continuously engaging building occupants and users; and
   - includes best practice guidelines on a user-centred approach to on-site environmental monitoring of in-use heritage buildings.

[1] The terms "user/s" and "occupant/s" have been utilised interchangeable throughout this research. Both terms refer to any person/s making permanent (i.e. residential) or temporary (e.g. office, guests, visitors etc) use of a building.

2. The study identified shortfalls in the existing infrastructure supporting the sustainable regeneration of built heritage in Malta, and developed recommendations to maximising the potential of passive environmental design strategies in providing comfort, thereby reducing energy demand. Having recognised the impact of occupant behaviour on this potential, the proposals were designed to be user-centric, focusing on:

- positive environmental behaviour;
- informed decision-making; and
- a supportive framework for the design and assessment of heritage building interventions.

Table of Contents

List of Figures

List of Tables

List of Case Examples

List of Abbreviations

3ENCULT	3 Efficient Energy for European Union Cultural Heritage
ACE	Architects Council of Europe
BICC	Building Industry Consultative Council
BRO	Building Regulations Office
CEN	European Committee for Standardisation (*French:* Comité Européen de Normalisation)
DC15	Development Control Design Policy, Guidance and Standards 2015
EC	European Commission
EDUCATE	Environmental Design in University Curricula and Architectural Training
EFFESUS	Energy Efficiency for European Union Historic Districts' Sustainability
EN	European Standards (*French:* Européen de Normalisation)
EPC	Energy Performance Certificate
HVAC	Heating, Ventilation and Air Conditioning
LEED	Leadership in Energy and Environmental Design
PA	Planning Authority
PEDS	Passive Environmental Design Strategies
REWS	Regulator for Energy and Water Services
SnAP	San Anton Palace
SRBH	Sustainable Regeneration of Built Heritage
STBA	Sustainable Traditional Buildings Alliance (STBA)
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WCED	World Commission on Environment and Development

Chapter: 1 Introduction

1.1 Research Context

1.1.1 Wider Research Context

The challenges of global warming have given the European Union the impetus to establish targets for the reduction of greenhouse gas emissions over the coming years, to be cut down by between 60% to 80% by 2050 from 1990 levels (European Commission Decision, 2009). The building sector is a major contributor to this problem, with residential buildings alone accounting for 10% of greenhouse gas emissions in the European Union (Kolaitis et al., 2013). Carbon dioxide emissions are strongly related to energy consumption (Caputo et al., 2013), and the construction industry is responsible for approximately 40% of total primary energy use worldwide (Hong et al., 2015). Consequently, the development of strategies targeting a decrease in energy consumption in buildings has become an international priority.

The construction industry is recognised as the largest single energy consumer in Europe (Urge-Vorsatz et al., 2007), and the greatest global consumer of raw material (Pacheo-Torgal and Jalali, 2012). Commitment to sustainability and energy efficiency goals is evident in European directives such as the Energy Efficiency Directive 2012/27/EU (Council Directive, 2012) and the Energy Performance of Buildings Directive 2010/31/EU (Council Directive, 2010). The existing building stock has been highlighted as a key area for potential energy use reductions through eco-refurbishment (Ouyang et al., 2011). This is addressed at European level through the revised the Energy Performance of Buildings Directive 2018/84/EU (Council Directive, 2018), which underlines the need for energy efficient retrofitting of existing buildings.

The importance of energy efficient retrofitting is clear when considering the significant proportion of present building stock and the predicted lifespan of between 50 and 100 years (Kolaitis et al., 2013). According to Romani et al. (2015), the potential for reducing pollutant emissions and energy demand and is notably significant within the Mediterranean building sector. This is especially true in the case of heritage buildings (Ascione et al., 2015). However, this typology presents a particularly challenging case, as a result of the numerous factors that must be considered in the development of eco-refurbishment solutions (Pisello et al., 2014).

Heritage buildings are a reflection of local culture and traditions. Inherent to Mediterranean vernacular architecture is the incorporation of passive environmental design strategies, such as the internal courtyard, south-facing loggia[2] and louvred apertures. Their evolution was sustained by a need to achieve environmental comfort in response to local climatic conditions (Fernandes et al., 2015). The energy consumption of a building, and therefore its sustainability, is influenced by the environmental conditions it provides. Optimal use of passive strategies to achieve comfort should enable a reduction in the use of active systems and hence of energy demand (Li and Colombier, 2009). Through the use of passive environmental design strategies, traditional techniques and local materials, vernacular architecture can contribute towards providing occupant comfort (Dili et al., 2010) and reducing waste and energy consumption (Fernandes et al., 2015).

[2] Loggia: A covered gallery or corridor that is open to the elements on at least one side, separating rooms from an external space.

1.1.2 A Case for Malta and San Anton Palace, Attard

Malta was adopted as a case study country for this research. The researcher has both a personal and professional interest in Malta. Having been born and raised in the country, she is familiar with its history and culture. In addition, having practiced as an architect and civil engineer in Malta for several years, she is also familiar with the vernacular architectural style, the traditional building techniques and materials, and the planning processes, policy and legislation. Her role as Honorary Secretary of the Chamber of Architects and Civil Engineers, has exposed her to pertinent policy issues and practical concerns experienced by, and as a consequence of, both the industry and the profession. As an advocate for the preservation and sensitive adaptive reuse of the local built heritage, she is specifically interested in identifying and promoting measures to safeguard this architectural typology sustainably. Malta is contextualised in Chapter: 3.

In Malta, a notable proportion of residential buildings (17% in 2014) were constructed prior to 1945 (European Commission, 2015). Moreover, most public buildings and several commercial buildings comprise heritage architecture. In this context, there exists significant potential to exploit the benefits of passive environmental design strategies in heritage buildings. The Building Industry Consultative Council (BICC) encourages the regeneration and reuse of older properties in Malta (BICC, 2015). However, the challenge remains to assess and achieve a balance between heritage value and environmental performance, in an effort to protect vernacular architecture and provide occupant comfort.

European guidelines targeting the improved energy performance of heritage buildings were published in 2017 (EN16883: 2017) to outline a procedural format for the selection of appropriate eco-refurbishment measures. It recommends a multidisciplinary approach based on collaboration between the professional team and occupants (Berg et al., 2017). However, although there is consensus that heritage value and environmental performance should both be incorporated into the decision-making process, qualitative studies in the field of energy behaviour have been limited (Berg et al., 2017). Similarly, whilst occupant behaviour has been cited as having significant potential in reducing energy demand, studies have mainly focused on contemporary buildings.

Studies such as the 3 Efficient Energy for European Union Cultural Heritage (3ENCULT) and the Palace of Westminster project (3ENCULT, 2014; University of Kent, 2016) have explored the gap between heritage and sustainability with the scope of identifying retrofit solutions to existing buildings. However, the literature has not examined occupants' perceptions of these buildings and the attitudes adopted towards them (Fouseki and Cassar, 2014).

This body of work seeks to contribute towards European targets for reductions in energy demand and emissions by tapping into the potential of heritage buildings, particularly in the context of Malta. There is a recognised need to focus not only on energy efficiency in new builds and renewable technologies, but also on the potential of addressing occupant behaviour and maximising the potential of passive environmental design strategies in heritage buildings.

Additionally, gaps in the field have been identified, including a dearth of: qualitative research on energy behaviour; studies on occupant behaviour focusing on heritage buildings; and research on users' perceptions of and attitudes towards heritage buildings. These gaps must be addressed in order to support the sustainable regeneration of built heritage.

As defined in this research, the sustainable regeneration of built heritage (SRBH) refers to a movement which promotes and facilitates the sensitive restoration and adaptive re-use of heritage architecture whilst balancing architectonic, cultural and heritage conservation with energy and environmental conservation, and accounting for user requirements, perspectives and behaviours (Figure *1.1*).

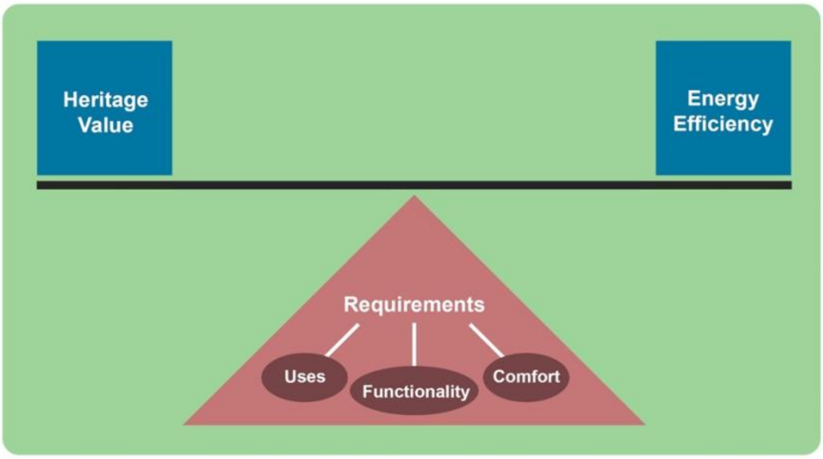

Figure 1.1: The balance model for the sustainable regeneration of built heritage
(Source: A Wismayer)

The use of passive strategies to improve occupant comfort not only has the potential to contribute towards energy reduction, but also raise the prospects of conserving vernacular architecture. This research develops a strategy for the sustainable regeneration of heritage buildings, thus safeguarding Malta's architectural legacy through sensitive, adaptive re-use. It investigates public perceptions and attitudes, as well as the level of awareness of passive environmental design strategies and their potential in providing occupant comfort. It also assesses the educational and regulatory infrastructure supporting interventions on heritage buildings.

San Anton Palace (SnAP), located in the village of Attard in Malta, was investigated as a case study building in this research. Since its inception in the 17th century, the building has played a prominent role in the country's history, serving as the official residence and office base to grandmasters, governors and presidents, and hosting political leaders, royalty and renowned poets (Freller, 2009). As well as depicting the country's national history, SnAP also reflects pertinent periods in Malta's architectural development. Having been modified and extended by its various patrons, the palace exhibits Baroque, British and contemporary design, rendering it a building of intrinsic historical and cultural worth (Soler, 2018). However, whilst being afforded the highest levels of protection, SnAP performs as a mixed-use working palace accommodating over 100 occupants and users. It features passive environmental strategies characteristic of vernacular Mediterranean architecture; therefore, the lessons learnt through a study of this building may be applied to a wider typology. The case study is described in further detail in Section 3.7.

1.2 Hypothesis

This research is based on the initial hypotheses that:
Traditional Maltese buildings were designed with passive environmental design strategies intended to improve occupant comfort. In the absence of a national strategy for the sustainable

regeneration of built heritage in Malta, the potential offered by the use of passive environmental design strategies is being compromised.

1.3 Aim of the Research

The primary aim of this research is twofold.

The context is initially narrowed to assess the comfort and environmental performance potential offered by a specific, highly complex heritage building. San Anton Palace, located in Attard, Malta, was used as a case study.

The scope is then widened to identify areas of priority in the infrastructural and legislative framework that enables the comfort and environmental performance of vernacular architecture to be maximised through optimisation of passive design strategies and consideration of uses and users.

The specific research aims are presented below.

Research Aim 1: To determine whether the inherent potential offered by passive environmental design strategies at San Anton Palace is being compromised.

Research Aim 2: To examine the different aspects of the sustainable regeneration of built heritage in Malta and determine whether these support the sensitive, adaptive re-use of historic architecture.

1.4 Objectives of the Research

The objectives of this research are outlined below.

Objectives associated with Research Aim 1
Objective 1A: Assess the architectonic[3] characteristics of San Anton Palace, and whether past interventions on the building fabric impact occupant comfort and environmental performance.
Objective 1B: Evaluate the attitudes, perceptions of comfort and functionality, and environmental behaviour of occupants and users at San Anton Palace.
Objective 1C: Identify use-related barriers to environmental monitoring in heritage buildings.

Objectives associated with Research Aim 2
Objective 2A: Evaluate the public's perceptions of the sustainable regeneration of built heritage and heritage buildings in Malta, and the level of awareness regarding the applications of passive environmental design strategies.
Objective 2B: Appraise the knowledge base, and level of awareness of stakeholders involved in designing and assessing interventions on heritage buildings.
Objective 2C: Determine whether the existing regulatory framework targets and supports all relevant parameters in the design and assessment of heritage building interventions.

The research objectives were fulfilled using the methods outlined in Chapter 4, and resulted in the conclusion, contributions, recommendations and outputs presented in Chapter 8.

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[3] The term 'architectonic' refers to the properties or principles relating to architecture that encompass wider aspects of a building such as: aesthetics, building features, structural elements etc.

1.5 Thesis Structure

This thesis is divided into eight chapters. Having outlined the research context, as well as the aims and objectives of this study, the limitations and contributions are presented in Sections 1.5. and 1.6. The remainder of this thesis is structured as follows:

- Chapter 2 provides a review of existing literature on the area of research;
- Chapter 3 describes the setting of the case study country and building;
- Chapter 4 outlines and justifies the adopted methodology and selected research methods;
- Chapter 5 presents and analyses the results of the case-specific study;
- Chapter 6 presents and analyses the results of the wider study;
- Chapter 7 discusses the research findings within the context of existing literature, and outlines recommendations developed to drive the sustainable regeneration of built heritage;
- Chapter 8 presents the conclusions of this research and its contributions to the body of knowledge, as well as summary of the key recommendations and outputs. It also provides a clear direction for future research.

1.6 Contribution to Knowledge

This research contributed to the wider body of knowledge by seeking to assess the impact of occupant behaviour on passive environmental design strategies in heritage buildings, using Malta as a case study country and San Anton Palace in Attard as a case study building.

The body of work sought to be of practical use by addressing two areas of international priority as identified by the European Commission (EC): the environment and heritage buildings. This work runs parallel to the provisions of European legislation and policy adopted by Members States. It is in line with the requirements of the Energy Efficiency Directive 2012/27 (Council Directive, 2012), and contributes to the drive towards reaching energy targets for 2020 and 2050, as stipulated by the European Union. It is also in line with the recommendations of European Directive 2018/84 (Council Directive, 2018), which stipulates that mechanisms to improve the energy performance of heritage buildings are studied, validated and promoted, whilst protecting cultural heritage.

Maximising the use of passive environmental design strategies in heritage buildings offers the potential to improve comfort conditions (Dili et al., 2010). The energy performance of heritage buildings is an international problem, as illustrated through literature (Adams et al., 2014; Fouseki and Cassar, 2014; Martínez-Molina et al., 2016; Moseley, 2016; Berg et al., 2017; Webb, 2017; Lidelöw et al., 2019). There are commonalities between countries and particularities to each: in this regard, there is scope for the practical application of principles across countries with comparable climates and cultures, which utilise similar building materials and technologies. Although this research considers Malta[4] as a case study country, and San Anton Palace as a case study building, the lessons learnt may be applied internationally, particularly across the Mediterranean. The study, therefore, contributes to a wider body of knowledge by exploring obstacles in maximising the comfort potential of heritage buildings, and proposing means of overcoming them.

In Malta, the reduction of energy demand is a priority at national level (Malta, 2018). Legislation, awareness campaigns and government incentives have sought to address energy efficiency in new construction (Building Regulations Act, 2011; Government of Malta, 2013;

[4] The climate conditions and vernacular architecture prevalent in Malta are described in detail in Chapter 3.

Zammit et al., 2015). Conversely, the importance of the existing building stock, particularly structures having historic architectural value, has been generally omitted. Moreover, focus has been placed on renewable technologies rather than passive principles as demonstrated by the incentives offered through the Regulator for Energy and Water Services (REWS) (REWS, 2019a; REWS, 2019b). This context highlights the importance of maximising the energy performance of heritage buildings by exploiting the potential of passive environmental design strategies as a first means of improving comfort. This research seeks to shift focus towards the performance potential of heritage buildings, and address the knowledge gap within the case study country in this regard.

Throughout this work, all relevant stakeholders were considered and consulted in identifying shortcomings of the current system, and mechanisms to overcome them. This research contributes to the existing body of knowledge by incorporating aspects of occupant behaviour and public perceptions, where knowledge gaps have been identified (Sustainable Traditional Buildings Alliance, 2012; Fouseki and Cassar, 2014; Berg et al., 2017; Lidelöw et al., 2019).

In line with Research Aim 1, the inherent potential offered by passive environmental design strategies at San Anton Palace was assessed. The results and recommendations are presented in Chapters 5 and 7 respectively. The assessment methodology developed and validated through this study, described in Chapter 4, is applicable to large-scale, mixed-use heritage buildings pertaining to the same architectural typology as the case study building. It may be adopted before designing interventions in order to:

- ensure that all pertinent parameters are investigated (Objective 1A);
- proactively and continuously engage building occupants and users (Objective 1B); and
- mitigate user-related barriers to environmental monitoring (Objective 1C).

In line with Research Aim 2, areas of priority in the sustainable regeneration of built heritage in Malta were identified. The results are presented in Chapter 6. Recommendations were developed to restructure and strengthen the supportive infrastructure with the scope of maximising the potential of passive environmental design strategies in providing comfort. These are outlined in Chapter 7. The study contributed to addressing gaps in the existing knowledge base by focusing on the impact of occupant behaviour on this potential, and designing proposals that target:

- building occupants and users, as well as the public, by promoting positive environmental behaviour (Objective 2A);
- professionals and academics, by enabling informed decision-making (Objective 2B); and
- policymakers and regulators, by manifesting a regulatory infrastructure that facilitates the design and assessment of sensitive, holistic and effective adaptive re-use and retrofit strategies for heritage buildings (Objective 2C).

Chapter: 2 Literature Review

2.1 Introduction

This chapter presents the challenges of sustainable development in buildings (Section 2.2), with focus on retrofitting. It also discusses the impact of occupants (Section 2.3) and the role of education (Section 2.4) in the sustainable regeneration of built heritage. Literature on the subject of eco-refurbishment of heritage buildings is addressed in detail (Section 2.5), outlining gaps in the body of knowledge.

2.2 Sustainable Development

2.2.1 Sustainability

The challenge presented by the inconsistency of the varied existing definitions of the term 'sustainability' is recognised in literature (Moore et al., 2017). Clearly (2011) questions the meaning of the term 'sustainable', and associates it with other ubiquitous words including 'green', 'environmentally-friendly' and 'eco-responsible', the meaning of which has been devalued. Johnston et al. (2007) concur with disappointment, noting that value of the original concept which interlinks aspects of economy, environment and social well-being.

Just as there is no distinct definition for sustainability (Berardi, 2013), there is also no single term for 'green': in fact, the labels 'sustainable building' and 'green building' are sometimes used interchangeably (Zuo and Zhao, 2014). Li et al. (2011) also use the term 'eco-building' interchangeably with 'green building'. However, Berardi (2013) notes that whereas a building may be termed green or eco if its environmental aspects are minimised, the benefits of a sustainable building are more wide-ranging, touching on social equity, cultural and heritage issues, traditions, occupant health, social infrastructure, as well as a safe and healthy environment.

The historic United Nation's World Commission on Environment and Development (WCED) Brundtland Report defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). This definition attributes clear focus on the importance of considering future needs. Johnston at al. (2007) postulates that in order to approach genuine sustainability, it is pertinent to acknowledge the temporal dimension and the rapid rates at which precious natural resources are being used up and at which the environment is being damaged. In this regard, there clear links between the Brundtland definition and term 'sustainable regeneration of built heritage', as defined in this research.

As previously described (Section 1.1.2), the SRBH refers to a movement which promotes and facilitates the sensitive restoration and adaptive re-use of heritage architecture whilst balancing architectonic, cultural and heritage conservation with energy and environmental conservation, and accounting for user requirements, perspectives and behaviours. There are numerous advantages to advocating the conservation of heritage architecture (Orbasli, 2009), including: the safeguarding of built heritage for future generations; conservation of embodied energy; maximal use of the existing building stock (reducing the need for new construction). These are augmented exponentially when the concept is paired with energy conservation based on the passive principles inherent to these buildings.

The SRBH is underlined by principles of equity and environment, both of which were primary foci in the WCED’s report (Sneddon et al., 2006). However, it also relates to the socio-economic aspects of sustainability. The concept is based on a drive to improve occupant comfort using passive means, wherein comfort and energy use (and, therefore, energy costs) are inversely proportional. Conversely, comfort is directly proportional to social well-being. In this regard, all aspects of the sustainability concept tie into this research.

2.2.2 Energy Demand in Buildings

Buildings contribute considerably to global greenhouse gas emissions (Moran and Natarajan, 2015) and energy consumption (Masoso and Grobler, 2010). They account for 30% of carbon emissions and 40% of energy use worldwide (Yang et al., 2014). The building sector plays an important role in reducing energy demand and greenhouse gas emissions (Persson and Grönkvist, 2015). However, the construction industry also presents considerable sustainability challenges in achieving energy savings and minimising environmental impact (Allouhi et al., 2015).

The increasing global awareness of sustainability issues has translated into an interest in green buildings (Mohammadabadi and Ghoreshi, 2011). In fact, it has been shown that being ‘green’ results in an increase of property value (Zhao et al., 2015). Moreover, the unceasing advancement in construction technology, materials and techniques continues to further the development of an eco-cultural society, in which the concept of green architecture is firmly rooted (Zhe et al., 2011).

Although the terms ‘green building’ and ‘sustainable building’ have evolved to encompass a multidisciplinary framework (Huseynov, 2011), as described in Section 2.2.1, the principles of sustainable development remain core values of the green movement. In the context of buildings, sustainable development is defined as an architecture that conforms to local socio-economic, cultural and environmental conditions (Correia Guedes et al., 2009). The primary role of buildings to provide shelter and protection, and promote health and comfort, has evolved to encompass minimising environmental impact (Zhe et al., 2011).

The Energy Performance of Buildings Directive (Council Directive, 2010) defines near zero-energy buildings as follows:

"Nearly zero-energy building means a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required shall be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby."

Marszala et al. (2011) note the complexity of the zero-energy building concept, highlighting the challenging energy balance calculation, which necessitates renewable energy generation systems on and/or off-site. Hernandez and Kenny (2010) favour the building's full life cycle energy balance, considering it a more appropriate period of calculation. Albeit, the Energy Performance of Buildings Directive designates a 2020 target for all new buildings to be near zero-energy buildings (Council Directive, 2010).

In achieving zero-energy targets, reference is made to the 'energy triad', which marries the objectives of reducing energy demand, adopting high-efficiency technologies and incorporating renewable solutions (Deprez and Cech, 2013). It has been contended that low-energy buildings should also incorporate reuse and recyclability, as well as a reduction in energy use and renewable energy sources (Li, 2011).

2.2.3 The Retrofitting Revolution

It is estimated that 70% of existing buildings will still be in use in 2050 (Power, 2008). The results of projects such as Innovate UK's Building Performance Evaluation Programme demonstrate that gains are possible if best practice design strategies are carefully applied following thorough evaluation and assessment (Palmer et al., 2016). In this context, the high retrofitting potential of these structures (Filippi, 2015) highlights the scope for eco-refurbishment. The retrofitting process targets the refurbishment and reuse of existing stock, championing savings in emissions during the embodied and operational lifecycle stages (Sodagar et al., 2009)

In response to a heightened awareness of the impact of the construction industry on the environment, retrofitting comprises an important tool with which to reduce the carbon footprint of urban landscapes. This mechanism of intervention presents clear advantages over demolition: these have been demonstrated through research (Power, 2008). Although retrofitting is a challenging process, projects such as Retrofit for the Future, by Innovate UK, have obtained promising results without impinging on heritage features: of 37 properties featured in the study, 26 achieved a reduction of over 50% in carbon dioxide emissions (Technology Standard Board, 2013)

The endorsement of energy efficiency improvements plays a pivotal role in achieving European Union targets of an 80% to 95% reduction in greenhouse gas emissions by 2050 from 1990 (European Union, 2012). There have been several policy mechanisms geared towards motivating energy efficient retrofitting, such as: energy performance ratings, financial incentives and energy audit tools (Wilson et al., 2015). Rivas et al. (2016) draw attention to specific provisions laid down in Article 17 of European Directive 2012/27 (Council Directive, 2012) requiring measures to be undertaken with the scope of highlighting advantages of energy efficiency improvements. These include: information dissemination, awareness raising and training.

However, research has identified barriers to higher rates of eco-refurbishment (De Boeck et al., 2015). These include: lack of capital financial resources, insufficient payback periods and uncertainty regarding realised energy savings (Dahlhausen et al., 2015). Additionally, there is a lack of available information to support decision-making (Wilson et al., 2015).

Several studies have examined available methodologies for identifying retrofit measures (Dahlhausen et al., 2015). Eco-refurbishment solutions may generally be categorised into one or more of the following intervention areas: building envelope (roof, walls, ceilings, floors), fenestration and shading, Heating, Ventilation and Air-Conditioning (HVAC) systems, and appliances and lighting (De Boeck et al., 2015).

In identifying appropriate eco-refurbishment measures, consideration should be attributed to indicators such as building energy end-uses and component contribution to peak loads (Dahlhausen et al., 2015). It is also pertinent to investigate building energy consumption (Ruparathna et al., 2016). Yet, despite the highly advanced computer software available to calculate energy performance, there still exits a notable discrepancy between predicted and actual value (de Wilde, 2014).

The difference between the computed and actual energy use is referred to as the performance gap (De Wilde, 2014). The phenomenon has been studied extensively, yet, the core source has not been effectively expunged (Zou et al., 2018). The performance gap may be due to a number of factors such as modelling error or faulty construction; however, the impact of occupant behaviour has been cited as a significant cause (De Boeck et al., 2015). In fact, the effectiveness of any retrofit solution is strongly influenced by how users interact with the building (Day and Gunderson, 2015). The impact of occupant behavior is tackled in depth through this research. The human element is discussed in further detail in the following section.

2.3 The Influence of Occupants

2.3.1 Impact of Occupant Behaviour on Environmental Performance of Buildings

According to Cole (1998), the definition of building performance, as well as the assessment method, will vary depending on the interest of each stakeholder: whereas investors may prioritise fiscal performance, the concerns of occupants may focus on air quality. In the context of this research, environmental building performance refers to the comfort conditions that the structure offers to its users. Occupant comfort is defined in Section 2.3.2.

Situating behavioural analysis within the wider context of eco-refurbishment can improve the results of the process (Wilson et al., 2015). Occupant behaviour plays a pivotal role in reducing building energy use (Ben and Steemers, 2014), and has been defined as one of the most important aspects of energy efficiency in buildings (Ouyang and Hokao, 2009).

Occupant behaviours comprise the actions and decisions of building users that influence energy use, and may include actions on apertures, lights, and computers (Klein et al., 2012). Research has highlighted the impact of occupant behaviour on adaptability and use of building technologies (Yan et al., 2015). Therefore, low energy consumption in buildings cannot be guaranteed through technology alone: rather, it should be supported by the appropriate interaction of occupants with the building (Hong et al., 2015a).

Interactive adaptation, defined as the way in which occupants interact with their homes, has an impact on building performance and resource use (Stevenson and Rijal, 2010). Education provides a tool for influencing occupants to interact with the building in a more energy-conscious manner, thereby reducing energy consumption (Henryson et al., 2000). In fact, the promotion of energy-saving measures has been shown to have a significant benefit of up to 10% reduction in household electricity consumption as a result of improving user behaviour (Ouyang and Hokao, 2009). This outcome, termed ‘green behaviour’, produces energy savings following positive behavioural changes (Ben and Steemers, 2014). Article 12 of European directive 2012/27 (Council Directive, 2012) targets encouraging ‘green behaviour’ as part of a national strategy. Measures adopted may include: exemplary projects, information dissemination and a variety of financial incentives.

Realised energy savings may fall short of predictions, as is often the case. A response known as the rebound effect may be a cause of this result (Ben and Steemers, 2014). This occurs when consumers increase energy use following retrofitting interventions and/or policy changes designed to improve energy efficiency (Doran et al., 2014). The rebound effect consequently results in higher energy consumption (Fan et al., 2016; Wang et al., 2016). In other words, savings gained from energy efficient retrofitting are reduced by increased carbon-intensive behaviour (Rowley, 2011).

Another possible cause may be the inability to accurately replicate occupant behaviour patterns through simulation tools. The behaviour diversity and complexity of users cannot be imitated by computer-modelling software, which generally replicate patterns in a rigid manner (Yu et al., 2011b). Energy use predictions are heavily influenced by the presence of occupants, and their interaction with building components, even when other controlling factors, such as climate, building characteristics and services have been defined (Yan et al., 2015). Therefore, it is clear that although the impact of occupant behaviour on building performance has been recognised and studied, knowledge gaps and restrictions to current methodologies still exist.

O'Brien and Gunay (2014) have listed the contextual factors influencing adaptive occupant behaviour as follows: availability and accessibility of personal control; complexity and transparency of automation systems; presence of mechanical/electrical systems; views to and connections with the outdoors; interior design; experiences and foreseeable future conditions; visibility of energy use; and occupancy patterns and social constraints. The integration of these in the design process is crucial to appropriate user decision-making.

The impact of human behaviour on building technologies and operation, and therefore on energy consumption, has been acknowledged but not yet clearly defined (Hong et al., 2015b). The inability to quantify the energy use attributable to building occupants is largely due to the variety of factors simultaneously influencing energy consumption. Yu et al. (2011a) classify these into seven categories: climate, building characteristics, user characteristics, building services, occupant behaviour, socio-economic factors and the required indoor environmental quality. However, some of these interlink substantially, and consideration must be given to the impact of the integrated factors. Consequently, the optimisation of building energy performance and comfort conditions is pivotal in the drive to reducing energy demand.

2.3.2 Occupant Comfort

For the purpose of this research, the term comfort was not limited to thermal comfort. Rather, it encompasses a number of parameters which impact on the physical comfort of humans within a building. In assessing occupant comfort, it is essential to define the parameters influencing user satisfaction. This perception is influenced by a number of physical factors, which include air/surface temperature, air quality and ventilation rates, lighting levels (Gupta and Chandiwala, 2010) and acoustics (McMullen, 2007).

The inherent characteristics of a building, therefore, translate into the occupants' perception of comfort by generating an indoor climate that directly impacts users.

Users' actions to improve internal comfort conditions account for a significant percentage of energy used in buildings (Yang et al., 2014). The drive to improve energy efficiency is, therefore, often paired with the objective of improving occupant comfort (Klein et al., 2012). This goal presents the challenge of optimising these two pertinent parameters.

Unfortunately, green design does not necessarily equate to a design that promotes occupant comfort and satisfaction. Paul and Taylor (2008) provided an indication of this through a study that examined the comfort and satisfaction perspectives of users of one green and two conventional buildings. Their research found no link between green design and comfort. This result was supported by a post-occupancy survey carried out by Hedge and Dorsey (2013), which identified issues regarding perceived health and performance in one of the two LEED Platinum buildings studied. Whilst the problematic building was energy efficient and sustainable, there were concerns regarding variability in air temperature, freshness, and quality, as well as noise.

There is clear merit in ensuring appropriate occupant comfort. The advantages include better user satisfaction and productivity (Wagner et al., 2007). It has also been shown that both greenness as well as comfort influence property value (Zhao et al., 2015). These factors result in financial spin-offs, which validate addressing energy efficiency and occupant comfort on an economic level alone.

Moreover, researchers including McMullen (2007) have determined a relationship between user health and building parameters, including physical comfort conditions. There is evidence that stress, depression and fatigue may result from the phenomena known as the Sick Building Syndrome (Harris and Borer, 2005). The prevention of disease is an established pillar of heath care systems (Benjamin, 2011), further validating the need to achieve a balance between energy efficiency and user satisfaction.

Another aspect, interactive adaptation, considers occupants' initiative in taking action to increase their own comfort levels. Day and Gunderson (2015) have shown that building users who receive effective training for high performance features are more likely to be satisfied with their environment. Consequently, occupants who understand how to change their environment in order to improve their comfort will be more satisfied than those who do not.

2.3.3 Influencing Occupant Behavioural Change

Education provides a tool for influencing occupants to interact with the building in a more environmentally-conscious manner, thereby reducing energy consumption (Henryson et al., 2000). The promotion of energy-saving measures has been shown to have a significant benefit of up to 10% reduction in household electricity consumption as a result of improving user behaviour (Ouyang and Hokao, 2009). This outcome, termed 'green behaviour' produces energy savings following positive behavioural changes (Ben and Steemers, 2014).

The Energy Efficiency Directive includes the requirement of providing information and raising awareness regarding energy efficiency mechanisms and measures to promote behavioural change (Articles 12 and 17 of 2012/27/EU). Although member states have responded to this obligation, it is clear that the results are not optimal and that the effectiveness of information dissemination depends to a large extent on the way it is delivered (Rivas et al., 2016). Rivas et al. (2016) recognise three main approaches: economic, environmental and social. The latter (integrating social norms) has been highlighted as a methodology so far un-utilised by member states. The importance of careful selection of the communication channel is also highlighted, as is targeting specific information to particular audiences, and monitoring and assessing the outcomes.

Whilst the provision of information is generally regarded as a pre-requisite in motivating the public, or occupants, some studies suggest that information alone will not necessarily result in behavioural change (Owens and Driffill, 2008). The latter is more likely if users are actively involved, and if the information being provided is customised to particular user-groups. In this context, surveys enable the identification of specific categories of users who respond differently to motivations for behavioural change (Berg et al., 2017). Focused feedbacks also increase user-engagement and commitment (Pasini et al., 2017).

Besides the provision of information, Article 12 of European Directive 2012/27/EU (Council Directive, 2012), visualises the use of financial incentives and exemplary projects as tools for behavioural change. Education and training are also powerful tools.

2.4 The Role of Education

The period between 2005 and 2014 was declared by the United Nations as the Decade of Education for Sustainable Development (Khataybeh et al., 2010), with the United Nations Educational, Scientific and Cultural Organisation, known as UNESCO, (UNESCO, 2005) stating that:

“Education for sustainable development is not an option but a priority.”

In 2012, member states renewed their commitment to the initiative (UN, 2012), and further reinforced this commitment through the post-2015 Sustainable Development Goals (Beynaghi et al., 2016). According to Khataybeh et al. (2010), embedding the principles of sustainable development in education will motivate students to consider and collaborate towards a sustainable future. Given the clear links between the sustainability agenda and the building industry, there is strong justification for basing construction degree curricula in higher education on sustainability principles (Murray and Cotgrave, 2007).

2.4.1 Sustainability in Architectural Education

Academic institutions play an important role in supporting future generations of academics, architects and civil engineers, and policy-makers to develop effective strategies for overcoming existing barriers in the sustainable regeneration of heritage buildings. Educational programmes have been revolutionised in order to enable learners across several disciplines to formulate innovative problem-driven solutions, despite information deficits (Altomonte et al., 2014; Hardin et al., 2016). For example, the Architectural Association, a prominent school of architecture in London, adopted a dynamic approach to education by annually revising the Graduate School’s Masters Programme in Environment and Energy Studies to explore different ways of assessing environmental performance and attributes (Yannas, 2005).

Altomonte et al. (2014) suggest that architectural and urban design curricula centring around sustainability should be developed with focus on the learning outcomes and contents delivered. The study recommends consideration of the following factors: teaching structure, including stages of delivering specific information; the learning methods, including lectures, seminars and workshops; the learning tools, including real-case projects and e-learning using advanced computer software; and the assessment criteria, including coursework, laboratory testing and site work. The developed programme should be based on a mission statement which prioritises sustainability from the beginning of the student’s education.

However, Taleghani et al (2011) note that the development of sustainable architectural education is hindered by ambiguous definitions of sustainable architecture, unclarity regarding the meaning of sustainability, and insufficient expertise in this field. Moreover, research examining the curricula of architecture degrees in Turkey has shown that, although the inclusion of aspects relating to sustainable architecture has improved, it remains incomplete (Yüksek, 2013). In contrast, studies, such as Environmental Design in University Curricula and Architectural Training (EDUCATE) have highlighted the successes of educational programmes which adopt more flexible and dynamic teaching techniques, and link academic education to the professional domain (Altomonte et al., 2014). The results of another study (Beynaghi et al., 2016) on the implications of sustainable development trends concluded that universities play an integral role in the advancement of sustainability through education, research and outreach.

2.4.2 Different Approaches in Education

Research encourages alternative approaches to the long-standing traditional teaching methodology. Charalambous and Christou (2016) questioned whether traditional architectural education programmes sufficiently equip graduates for the challenges they will face in practice. The study outlines the benefits of an investigative approach to learning, supporting practical application of concepts, and highlights the potential offered by the design studio to link academia with the profession. Further research (Altomonte et al., 2014) has shown that the use of experiential learning aids, including case studies, field trips, laboratory use, and computer applications, may increase the awareness, motivation and interest of undergraduates. Adopting different forms of learning methods, such as workshops has also been shown to be beneficial (Roulet, 2006). Ibrahim et al. (2007) promote the use of collaborative teamwork through roundtable discussions, project review sessions and critiques, and brainstorming sessions, supported by advanced computer technologies. This approach challenges the student.

Problem-based learning also challenges the student, increasing interest in the topic and rendering the knowledge and skills gained more memorable in preparation for life-long learning (Altomonte et al., 2014). As part of the problem-based learning approach, Ibrahim et al. (2007) encourage mentoring and reverse mentoring. Through this system, the student is supported in developing trans-disciplinary skills by interacting with a design team. The mentor may also learn from this experience by being exposed to innovative technologies, skills and ideas.

Hardin et al. (2016) advocate an evolution of the case-based method, whereby students are involved in developing course content through engaged learning and strengthening of existing cases. This initiative has registered a positive initial experience, and is being developed further through strategic, community-building efforts. Charalambous and Christou (2016) also advocate practice-based learning as a means of engaging students and encouraging them to develop creative solutions to real-case projects. The effectiveness of a practical approach to education is further highlighted by Gulay Tasci (2015), who proposes utilising built and natural environments, such as the school building itself, as a learning tool for students to explore sustainability principles.

Student-involvement at the development stage of a real-case sustainability-based project at Curtin University of Technology in Perth, Western Australia, was found to improve the quality, scope and probability of implementation (Karol, 2006). In this context, the importance of designing school buildings using these sustainability principles is emphasised (Gulay Tasci, 2015). The University of Arizona's College of Architecture, Planning and Landscape Architecture undertook an education, research and community outreach programme, conducting energy audits and identifying efficiency opportunities for greening the campus (Chalfoun, 2014).

An effective learning environment motivates and enthuses students to engage in the task of seeking knowledge (Altomonte et al., 2014), whichever approach is adopted. Student engagement and interest were found to improve the efficacy of the process, and may be achieved through a learning environment which fosters enquiry, discussion and practical application, allowing the student to establish links between key concepts (Altomonte et al., 2014), such as heritage and energy conservation. Analytical and cross-referencing skills, as well as imaginative and independent thinking, provide a basis for interest-led deep learning, which Warburton (2003) promotes as a learning method to maximise the benefits of sustainable architectural education. The study notes that successful programmes should enable the student to develop a flexible style of learning, by focusing on contextual interpretation rather than course content to develop both knowledge and understanding.

Deep learning is also encouraged by Altomonte et al. (2014), as a means of embedding sustainability in the academic programme. The study emphasises the need to provide students with technical knowledge of sustainable design, as well as the skills and competence to apply it creatively. This should be supported by an understanding of the multidisciplinary nature of a project and, in this context, the study also highlights the importance of cross-disciplinary teaching in sustainability.

Several disciplines have a shared interest in the principles of sustainability (Gulay Tasci, 2015). Spanning across these disciplines to facilitate sustainability education has been shown to produce positive results (Warburton, 2003). In this light, Ibrahim et al. (2007) recommend that trans-disciplinary learning is incorporated in the architectural curriculum. They define the trans-disciplinary teaching framework as targeting a particular issue, such as sustainability, and incorporating perspectives from and beyond the boundaries of the discipline. This is implemented through an approach which facilitates collaboration of the educational team members and the collective contribution of beneficial knowledge and skills (Ibrahim et al., 2007). In architectural education, trans-disciplinary teaching aims to develop an understanding of the multi-faceted built environment, which is impacted by several fields. It also aims to prepare the graduate for professional team scenarios in practice.

Although studies (Ibrahim et al., 2007; Altomonte et al., 2014; Gulay Tasci, 2015) highlight the importance of broadening teaching for undergraduates to encompass subjects that are not traditionally associated with sustainability, to the authors' knowledge none of the literature makes direct reference to the correlation with heritage conservation in higher education. This highlights a gap in existing research whereby teaching models integrating the concepts of heritage and energy conservation, as part of the sustainable regeneration of built heritage, have not been assessed.

2.4.3 Training and Continuing Professional Development

Studies on insulating heritage buildings, carried out by Historic Environment Scotland, identified the need for education and training targeting specific stakeholders, namely building owners, professionals and contractors (Jenkins, 2016). It was concluded that training delivery should be customised to the different groups, as described below:

- Building owners: concise presentations to increase awareness, and e-learning modules on energy efficiency;
- Professionals: dissemination of detailed evidence-based data; and
- Contractors: hands-on demonstrations of techniques.

According to Jenkins (2016), a combination of custom-designed programmes, developed on a strong knowledge base established through technical research, will ensure that stakeholders receive adequate understanding and skills to collectively improve energy performance of traditional buildings. The study also emphasised the importance of establishing a comprehensive strategy to raising awareness on the eco-refurbishment of heritage buildings, through education and training.

A similar project was undertaking by the Townscape Heritage Initiative in Cornwall. Training days were provided for contractors and architects, focusing on retrofitting traditional buildings (Richards et al., 2016). The programme was complemented by work experience for local college students who learnt practical techniques for repairing, rather than replacing, heritage buildings elements.

Literature (Altomonte et al., 2014; Hardin et al., 2016) has demonstrated that connecting education to practice in sustainability is as integral in academia as continuing professional development is in the private, non-profit and public sectors. Altomonte et al. (2014) highlight the importance of linking advances in academic education with similar initiatives in the professional domain, such as linking continuing professional development for educators and professionals with changes in legislation, and the use of best practice cases to strengthen design methodologies. This study notes life-long learning as a priority, and proposes measures to facilitate this. Such measures may include continuing professional development initiatives and part-time further education, as well as academic and design research, with the provision of advanced analysis tools to support the latter in the development of innovative solutions.

2.5 Eco-refurbishment of Heritage Buildings

The existing building stock in most Euro-Mediterranean countries varies dramatically, ranging from contemporary construction to heritage architecture. Approximately 25% of the European built environment consists of historic buildings (Moran et al., 2014). Şahin et al. (2015) argue that energy efficient retrofitting should be implemented using different approaches according to typology, ensuring particular care for the historical, sociocultural and architectural values associated with heritage buildings.

2.5.1 Energy Efficiency and Heritage Buildings

Studies have shown that significant energy savings can be achieved without impinging on a property's heritage value (Şahin et al., 2015). Notwithstanding this, proposals designed to improve the energy performance of heritage buildings must face the challenge of harmoniously merging several different aspects (Pisello et al., 2014). These include respecting the protection status of historic features, satisfying modern requirements generated by the new use, retaining balanced environmental conditions for artefacts and achieving comfort requirements for occupants (López and Frontini, 2014). The optimum retrofit should result in a rational balance of these components.

In addressing the heritage building typology, it is essential to delineate what may be considered to be a heritage building. A heritage building may be defined as a structure of architectural, social or heritage value, having features or characteristics deemed desirable to preserve and generally exhibiting traditional construction (Doran et al., 2014). It has also been contended that buildings pre-dating the large-scale reconstruction that followed the Second World War (i.e.: pre-1945), and the subsequent industrial revolution in Europe, may be classified as a heritage buildings (Filippi, 2015). However, several sub-categories exist within this definition, having varying degrees of historical, architectonic and cultural value. Energy retrofits should be custom-designed to meet the unique needs of these typologies by developing a thorough understanding of the characteristics and use of each.

In order to address the requirements of both energy and heritage conservation, Ben and Steemers (2014) advocate a balanced approach to the eco-refurbishment of protected buildings. The effect of occupant behaviour on energy consumption renders it a key consideration in the retrofit process (Moran et al., 2014). Tackling this aspect is vital, since it has the highest energy savings potential in heritage buildings (e.g. Böttcher, 2014a; Fouseki and Cassar, 2014).

This context highlights the importance of maximising the energy efficiency of heritage buildings through restoration, eco-refurbishment and sensitive adaptive re-use. These concepts form the foundations supporting sustainable development. In fact, development without historic preservation is not sustainable. Internationally, the relationship between conservation and sustainability has been recognised. The energy efficiency of heritage buildings has been targeted by the Architects Council of Europe (ACE), and discussed repeatedly by the Environment Sustainable Architecture and Urban Issues Work Group[5] (ACE, 2014).

2.5.2 Aspects of Heritage Building Assessment

Heritage buildings present particular challenges in their assessment since they comprise complex systems exhibiting a balance between several factors. It has been postulated that there is insufficient information about the individual and combined influence of these factors on the building's energy profile (Doran et al., 2014). Technological solutions alone are inadequate; rather retrofit decisions should also be derived from behavioural data (Chiu et al., 2014). Therefore, in profiling the energy demand of this typology, the adopted approach should include assessing user behaviour and building monitoring.

2.5.2.1 The Building Occupants and Users

The impact of occupant behaviour has proven difficult to quantify (Yu et al., 2011a). Perception of comfort is mainly subjective and, moreover, statistically significant quantified data would require large-scale studies (Fouseki and Cassar, 2014). Berg et al. (2017) advocate qualitative studies to understand energy behaviour in historic buildings, and encourage the use of case studies to explore how users interact with the building. User interaction with the building will often have greater impact on energy demand than technological solutions to improve energy efficiency (Fouseki and Cassar, 2014). However, there is a dearth in the literature addressing the energy-use interactions of occupants with heritage buildings (Sustainable Traditional Buildings Alliance, 2012; Lidelöw et al., 2019).

Thermal comfort and temperature control have a significant impact on building energy use (Day and Gunderson, 2015). Users' perception of thermal comfort, as well as their expectations and satisfaction, may be gauged through interviews with occupants. The retrofit of heritage buildings should, therefore, include occupant consultation such that user perspectives and requirements may be identified and incorporated to ensure viable

[5] Environment Sustainable Architecture and Urban Issues Work Group: a working group set up through the Architects Council of Europe, that comments on aspects related to energy-efficient building, energy efficiency retrofits and eco-refurbishment of heritage architecture.

solutions. The results of this assessment should be used to influence the choice of specific features of the retrofit solution (Gupta and Chandiwala, 2010).

One aspect of occupant behaviour is the influence that space layout and furnishings may have on users' energy behaviour. This is an area which requires further research, having been largely overlooked (Delzendeh and Wu, 2017). Understanding how occupants use a building, and designing interior spaces with this in mind, has the ability to reduce energy consumption. This is reinforced by the observations of Adams et al. (2014) who contend that the use of windows to provide natural light and ventilation should be optimised by room layout. Windows should be seen as the primary source of effective ventilation and lighting, with mechanical systems supporting them when necessary (Adams et al., 2014). This way of modifying user interaction with the building enables a reduction in energy demand (Bottcher, 2014a).

The context of the building's use is imperative in relation to this topic: for example, differentiating between residential and administrative uses. It has been postulated that in the latter case, a building's energy performance may have less to do with its intrinsic physical characteristics, than with the interior design layout imposed upon it (Adams et al., 2014). Individual users often have little or no ability to control the communal heating, cooling or lighting system. Giving some degree of control to the occupants could mitigate this, e.g. using desk-specific lighting. The design of the interior space should, therefore, be carefully considered in relation to its use (Adams et al., 2014).

There are other modalities which offer the possibility of influencing behaviour through changes in perception. Biophilic design, which advocates the incorporation of nature into design, may target the mitigation of environmental impacts, the maximisation of end user satisfaction, and improved health and well-being (Edge and Hayles, 2017). Studies suggest that biophilic design strengthens sustainability values and bolsters environmentally-friendly behaviour (Hayles and Aranda-Mena, 2018). This may translate into energy-conscious behaviour, resulting in a reduction in the use of active control systems.

Information may also modify users' views on what constitutes comfort in a particular setting. Consequently, occupants' assessments of appropriate levels of light or temperature in a heritage building do not necessarily coincide with their estimation of comfort in a modern environment (Adams et al., 2014). Appreciation of historic value influences the way users view, or are prepared to compromise on, comfort. This suggests that informing occupants about the heritage value of the building, has the potential to condition their energy behaviour positively (Berg et al., 2017).

2.5.2.2 The Building

Building assessment and survey comprises an integral component of the process defined by the recently published European guidelines on improving energy performance in heritage buildings (EN16883: 2017). The European Committee for Standardisation (CEN) standard advocates a process which includes architectonic assessment. Construction variables relating to physical building parameters, such as position and size of windows, and surface treatments, have been found to impact on energy performance (Yasa et al., 2014). These factors may be best identified through a comprehensive architectonic survey.

In some cases, the survey should be complemented by environmental building monitoring, as suggested by European guidelines (EN16883: 2017). Environmental monitoring is an integral tool in developing an understanding of building performance, energy use, occupant comfort and building operations (Guerra-Santin and Tweed, 2015). It is a crucial part of the retrofitting process (Lovett et al., 2017). As explained in Section 2.3.1, the impact of occupant behaviour on building energy performance is widely accepted yet not fully understood (Hong et al., 2015b). This influence has been registered as one of the causes for the mismatch between predicted and actual energy consumption in buildings (Delzendeh and Wu, 2017).

The use of data loggers and wireless sensor networks in monitoring environmental criteria has been endorsed (Zhang, 2013; Lovett et al., 2017). Guidelines to the monitoring process mainly relate to identifying the most suitable method, rather than the implementation. Guerra-Santin and Tweed (2015) list the following determinants: objective of the monitoring activity; target audience; nature and depth of research; available performance indicators; data and research methods; and building typology.

It is recognised, however, that there are barriers related to the monitoring process. Besides the issue of time, and the necessity for expert involvement, Guerra-Santin and Tweed (2015) point to cost and the intrusive nature of the process as possible constraints. These issues must be addressed if post-occupancy evaluation is to become widely adopted in standard practice, and not limited to assessing serious complaints or exceptional buildings. Whilst low-cost sensors have now been developed, negating the need for specialist equipment (Lovett et al., 2017), the intrusive nature of the monitoring process remains an obstacle. The occupants' lack of willingness to support the use of data loggers may result in compromised data. Reasons for users' lack of cooperation may include possible damage to loggers, inconvenience and being under surveillance with attendant privacy issues (Guerra-Santin and Tweed, 2015). Means of mitigating user-related barriers have not been addressed through research so far.

2.5.3 The Case for Research

Heritage buildings and their energy performance is a rapidly growing field of research interest (Martínez-Molina et al., 2016). The European Commission has taken a lead in financing research programmes which seek to improve these buildings' energy efficiency without compromising heritage significance. Studies have ranged from those addressing energy efficiency of urban districts with historic value (e.g. Energy Efficiency for European Union Historic Districts' Sustainability - EFFESUS) to others which target solutions for eco-refurbishment (e.g. 3 Efficient Energy for European Union Cultural Heritage - 3ENCULT). The results have contributed substantially to the sharp increase in published studies over recent years on energy efficiency of heritage buildings (Lidelöw et al., 2019). Despite this, in their review of current literature, several authors have highlighted areas of unclarity and ambiguity as well as gaps in knowledge in the sustainable regeneration of built heritage (e.g. Fouseki and Cassar, 2014; Martínez-Molina et al., 2016; Lidelöw et al., 2019).

In contrast to earlier attitudes which considered energy retrofitting of historic buildings as a threat, eco-refurbishment is now being increasingly seen as a means of preserving this architectural typology (Webb, 2017). This has brought to the fore the need to investigate and understand other criteria besides the main components of heritage and energy which may also influence the sustainable regeneration of built heritage.

In their review of the literature, Lidelöw et al. (2019) state that there is a need to address how energy efficiency and heritage conservation may be integrated in practical terms, for example through exemplary projects. They cite a number of studies highlighting that research in this area has mainly taken a technological approach and argue for more trans-disciplinary studies.

Fouseki and Cassar (2014) draw attention to a gap in the literature examining occupant interactions with heritage buildings, a crucial parameter shown to have a potentially greater impact than energy efficiency technologies in this context. Berg et al. (2017) agree, and argue that users may exhibit attitudes and behaviours which may be particular to heritage and which should be considered during retrofits.

It is also acknowledged that research is needed to detail criteria and methodologies, and to develop tools enabling improved decision-making in this field (Webb, 2017). There is a growing awareness of the need for standards and practice-guidance, both for national authorities, as well as for operators in the field (Lidelöw et al., 2019). There is also a need for research to support professionals in decision-making, and to collate customised information for the public that targets improved energy efficiency in heritage buildings. The literature also shows that policies and guidance may not always gauge the needs of the public, thus proving ineffective and unrealistic (Fouseki and Cassar, 2014). Moreover, the infrastructure guiding this field should support the sustainable regeneration of built heritage, and make it feasible. More work is, therefore, needed to capture and address the needs and concerns of stakeholders, including an understanding of motivations which work best in a given cultural context.

Fouseki and Cassar (2014) contend that besides investigating stakeholder perceptions of, attitudes to and behaviour towards heritage buildings, further research should also examine policies in use, and what improvements can be made to support both policy and practice. For instance, whilst agreeing with the principles of the CEN guidelines for improving energy performance of heritage buildings (EN16883: 2017), Berg et al. (2017) contend that the methodology should cater for user inclusion throughout the decision-making process and post-intervention. Robust and wider data are also required to monitor and evaluate the results of the various policy measures taken in this field (Moseley, 2016).

2.6 Concluding Remarks

Chapter Two presents a review of existing literature on the subjects outlined in the previous chapter. The concept of sustainability is discussed in the context of the built environment. Theories on the influence of occupant behaviour on environmental performance are presented, and gaps in the knowledge base are identified. The role of education is highlighted and pertinent publications on the eco-refurbishment of heritage buildings are reviewed.

The literature review supports the argument that although when compared to near zero energy buildings, retrofitted heritage buildings may only offer limited scope in energy savings, collectively they may contribute to a significant reduction in energy demand. Furthermore, the sustainable regeneration of built heritage, with a focus on the potential of inherent passive strategies, also has additional benefits including: occupant comfort and well-being; and the long-term conservation of vernacular architecture reflective of cultural value.

The chapter demonstrates that further research is required to understand the impact of occupant behaviour on passive environmental design strategies in heritage buildings, as well as best practice guidelines on the pre-design assessment of vernacular architecture. In this context, Chapter Three presents the case study country and the case study building, and justifies the use of both are foci of this research.

Chapter: 3 Malta: A Case Study

3.1 Introduction

This chapter describes the background to this research, which was conducted with a focus on Malta (Figure *3.1*), as a case study country, and using San Anton Palace in Attard as a case study building. Section 4.3 justifies the use of case study research as a methodology, and describes the methods adopted to gather and analyse data.

Figure 3.1: Malta's capital city, Valletta, as seen from the Grand Harbour
(Source: A Wismayer)

Chapter: 3 provides a context for the eco-refurbishment of heritage buildings in Malta (Section 3.2). It also outlines the existing infrastructure for the sustainable regeneration of built heritage, having considered the government's commitment to promoting this field (Section 3.3), the education framework supporting it (Section 3.4) and planning policies and systems catering to it (Section 3.5). Section 3.6 centres on Maltese vernacular architecture, and inherent passive environmental design strategies characteristic of similar Mediterranean countries. Lastly, San Anton Palace, the case study building, is presented in Section 3.7.

3.2 A Context for Eco-Refurbishment of Heritage Buildings in Malta

Given Malta's abundance of heritage buildings (Figure *3.2*) presents a typical example of this typology), huge potential exists to exploit the benefits of energy efficient retrofits and sustainable interventions. However, whereas the regeneration and reuse of older properties is encouraged (BICC, 2015), the role of eco-refurbishment remains generally unacknowledged.

Figure 3.2: One of several heritage buildings in Malta - Verdala Palace, Dingli
(Source: A Wismayer)

It has been emphasised that public buildings should serve as role models in the shift towards retrofitting, thus incentivising the market (Economidou et al., 2011). The Energy Efficiency Directive (2012/27/EU) obliges Malta to adopt national building renovation strategies (Article 4), including the eco-refurbishment of public buildings (Article 5), many of which have heritage value. The Maltese government is the custodian of several heritage buildings, the eco-refurbishment of which may serve to demonstrate what can be achieved through energy efficient retrofits. Successful implementation would provide an impetus for the private sector to take up the challenge.

The restoration and conversion of the Holy Infirmary in Valletta exemplifies the successful adaptive re-use of a heritage building in the Maltese context. The transformation of this 16th century hospital into a multi-functional conference centre was awarded the Europa Nostra prize (Rudolf and Berg, 2010). This demonstrates that there is the potential to re-utilise heritage buildings.

According to Lidelöw et al. (2019) the preference for non-invasive solutions is a recurring theme in literature on eco-refurbishment of historic buildings. It is generally felt that retrofit options in this context are limited since they should have a low impact on the architectural and cultural character of the building. Exploiting the potential offered by passive systems intrinsic to vernacular architecture could help to reduce reliance on mechanical systems and therefore on energy demand (Lidelöw et al., 2019).

3.3 Commitment to Heritage Conservation and Energy Efficiency

A relatively recent governmental initiative has been the introduction of grants as incentives towards either energy efficiency or heritage conservation. These have proved very successful with the public. Examples are presented below.

3.3.1 Incentives to Heritage Conservation

The *Irrestawra Darek* scheme (Planning Authority, 2019a) is a restoration grant through which works on the facade of residential properties located in an urban conservation area (defined in Section 3.5.2.1) may be subsidised (70% up to €10,000). For listed buildings, the grant also covers the interiors. The scheme, which is in its third edition, is repeatedly fully subscribed. Figure *3.3* illustrates facades that (from left to right) are undergoing, require or have undergone restoration works.

Figure 3.3: A streetscape of heritage building facades that (from left to right) are undergoing, require or have undergone restoration works

(Source: A Wismayer)

The Marsamxett Balcony Grant Scheme (Planning Authority, 2018a), administered by the Planning Authority and 80% funded by the European Union, subsidises the cost of restoring, replacing or maintaining a traditional open or closed balcony over the Marsamxett waterfront (the historic side of one of the two harbours flanking the Valletta peninsula) up to a maximum of €8000. Figure *3.4* depicts some of the balconies which may benefit from the grant. While the scheme refers to retrofitted green initiatives compatible with heritage value, its guidelines also state that the original design of the balcony should be retained, thereby limiting deviation from traditional design.

Figure 3.4: Timber balconies overlooking Marsamxett Harbour, Valletta
(Source: A Wismayer)

This negates the possibility of supporting innovative design, such as *Gallarija Miftuha* (Open Balcony), a project by Chris Briffa Architects which reconfigures the construction of a traditional Maltese closed balcony to enable its panels to fold aside, turning it into an open balcony (Figure *3.5*). The firm claims that this solution is an alternative to an alleged practice of owners allowing their balconies to naturally deteriorate while installing large panes of glass behind them in order to maximise their views (Briffa, 2013). It is therefore in line with the principles of heritage conservation, occupant comfort and adherence to modern requirements.

Figure 3.5: Gallarija Miftuha, designed by Chris Briffa Architects
(Briffa, 2013)

3.3.2 Incentives to Energy Efficiency

The Regulator for Energy and Water Services (REWS) subsidises up to 50% of the cost of Photovoltaic Panels installed in private residences up to a maximum of €2300 (REWS, 2019a). This scheme has been repeatedly fully subscribed.

A similar grant, which covers solar water heaters, has also proved popular (REWS, 2019b).

3.4 Formal Education on the Sustainable Regeneration of Built Heritage

The Faculty for the Built Environment at the University of Malta offers the only means of reading for an architectural and structural/civil engineering degree in Malta. A recent restructuring of the course has resulted in the phasing-out of the five-year degree, and the introduction of a tiered structure, as described below (University of Malta, 2019a):

- A Diploma in Design Foundation Studies (one year) provides an overview of history, art and design;
- The Bachelor of Science degree in Built Environment Studies (three years) incorporates architectural, structural/civil engineering and planning subjects;

- The professional Masters (two years) degree allows for the study of specific professional competencies in the three outlined fields, two of which, architecture and structural/civil engineering, qualify the graduate to prepare for the local state-awarded warrant in either practice; and
- Further specialisation is offered through research-based post-graduate degrees.

The programme of study comprises lectures, assignments, design projects, and a dissertation and thesis, featuring a combination of mandatory and elective units (University of Malta, 2019b; University of Malta, 2019c). Amongst other subjects related to the built environment, the Bachelor (University of Malta, 2019b) and Masters (University of Malta, 2019c) degrees' curricula features a range of credits addressing the concepts of building science and physics, sustainable development, energy efficient design, vernacular design, conservation, and Maltese built heritage. Therefore, graduates should have the competence to understand basic principles of sustainable regeneration of built heritage, and their application.

Having successfully completed the academic programme, the graduate is eligible to undertake a professional traineeship, spanning a minimum period of one year, and leading to the examination required to gain the Warrant of *Perit* (Kamra tal-Periti, 2018a). The term *perit*, or *periti* in plural, is the official umbrella title given to a warranted architect and civil or structural engineer in Malta (Kamra tal-Periti, 2018b).

Legislation does not oblige periti to undertake continuing professional development courses throughout their professional career (Periti Act, 2010).

3.5 Infrastructure for the Sustainable Regeneration of Built Heritage

This section describes the entities and systems involved in the sustainable regeneration of heritage buildings in Malta.

3.5.1 Development Regulation in Malta

Development planning in Malta is regulated by the Development and Planning Act of 2016, the aim of which is sustainable planning and the management of building development (Development Planning Act, 2016). The Act establishes a Planning Authority, composed of an Executive Council and a Planning Board. The former is responsible for the operational functions of the Authority, namely the formulation of planning policies, processing of planning applications, the enforcement of planning laws and action against breaches. The latter is responsible for the issuance of planning permissions following their assessment and a recommendation issued by the Executive Council.

Development, as defined by Article 70 of the Act, is not restricted to the construction of new buildings, but includes any alterations to existing buildings and the change of use of spaces, among others. Restoration is not singled out as development but any works which affect the external appearance of a building, or any internal modification that goes beyond basic maintenance would be considered an alteration and would therefore require planning permission.

3.5.2 Assessment of Development Related to Heritage Buildings

Applications for the change of use of, or alterations to, heritage buildings go through the same channels as any other planning application. These are assessed by the Executive Council through its Planning Directorate which issues a recommendation prior to a final decision being taken on the proposal by the Planning Board. The internal mechanisms of the Planning Directorate to appropriately deal with planning applications for heritage buildings are not prescribed by law, but the following provide a level of internal safeguards:

3.5.2.1 Urban Conservation Areas

Urban Conservation Areas (UCAs) are zones in almost all localities that are designated for general heritage preservation by the Maltese Local Plans. Figure *3.6* illustrates the Urban Conservation Area of Balzan, which is typical of UCAs across Malta.

Figure 3.6: Urban Conservation Area of Balzan, Malta
(Source: A Wismayer)

Applications for development in these zones are assessed by a dedicated team, referred to as the Urban Conservation Area Team, to maintain a level of consistency in heritage preservation standards, as well as, to provide a more sensitive assessment than would be provided for development in less sensitive areas.

There are however instances where heritage buildings do not fall in UCAs, such as heritage buildings located outside the development zone (e.g. vernacular farmhouses), or buildings located in areas which have otherwise been developed more recently. The former are generally assessed by a team dedicated to applications outside of the development zone while the latter (which may or may not be afforded heritage scheduling) are assessed by a team that assesses applications within the development zone and outside of UCAs.

In order to reconcile the potentially different approaches to conservation across all these teams, there exists a Heritage Planning Unit within the Planning Directorate that provides general guidance in terms of acceptability, and which assesses technical Restoration Method Statements submitted by periti.

3.5.2.2 Planning Authority Policy: Urban Conservation Areas and Energy Efficiency

The planning policies regulating buildings in Urban Conservation Areas are found in the Authority's general planning guide, the Development Control Design Policy, Guidance and Standards 2015 (DC15) (Zammit et al., 2015). The broad policies of this document (Policy P45 *Development Amenity*, Good Practice Guide G25 *Design for Energy Conservation and Resource Management*, and Policy P48 *Integrated Design of Sustainable Materials and Systems*) refer to the requirement for buildings to include passive and active elements of energy conservation.

Policy P48 places restrictions on the installation of photovoltaic cells on scheduled buildings, requiring them to be placed flat on the roof and requiring integrated water heaters in Urban Conservation Areas to be placed at the rear of the building to preserve the street's integrity. Otherwise, there appears to be no policy reconciling energy efficiency in heritage buildings.

Despite there being such specific policies in the DC15 to encourage energy conservation, the Planning Authority does not asses energy performance. A negative recommendation based on poor energy consciousness is not standard practice.

3.5.2.3 The Superintendence of Cultural Heritage

Apart from the internal mechanism of the Heritage Planning Unit, all planning applications (whether heritage buildings or not) must legally (Development Planning Act, 2016) be sent to the Superintendence of Cultural Heritage. This is a government body whose purpose is to ensure the protection and accessibility of cultural heritage (Cultural Heritage Act, 2002). Apart from its role in the planning process, which is significant when proposals pose heritage concerns, the Superintendence of Cultural Heritage is also involved in assessing which properties in Malta would require heritage scheduling.

3.5.3 The Building Regulation Office

The Building Regulation Office (BRO) was established through the Building Regulation Act of 2011 (Building Regulation Act, 2011) and is responsible to regulate the energy performance of buildings. At present, the BRO requests an energy performance certificate for all properties being sold, in line with Article 13 of Legal Notice 47/2018 (Building Regulation Act, 2011).

The same Legal notice also requires the Building Regulation Board to establish building energy performance requirements. The Legal Notice states such standards are to be applied to all new builds as well as buildings undergoing major refurbishment.

3.5.4 The Chamber of Architects and Civil Engineers

The Chamber of Architects and Civil Engineers (Kamra tal-Periti) is the body with the legislative authority to regulate the profession in Malta, as well as to advise government on pertinent matters. In this role, in May 2019, it presented a Public Consultation Paper targeting a modern building and construction regulation framework for Malta, to which this research contributed (Kamra tal-Periti, 2019a).

The Chamber highlighted the need for a review of current building and construction regulations, and advocates for performance-based standards and guidelines. It recommends that the Planning Authority should move away from the assessment of building regulations and focus on aspects related to planning. It has also emphasised the need for customised training for operators in the field. The timely proposals put forward in the Chamber's Public Consultation Paper coincide well with a government proposal for a Building and Construction Authority, which would consolidate the presently fragmented framework (Malta, 2018).

Although not part of the governmental infrastructure, the Chamber can, and does, play an important role in the sustainable regeneration of built heritage in Malta.

3.6 Maltese Vernacular Architecture

The regional climate has a fundamental and determining impact on the preferable strategy for eco-refurbishment. The local context must, therefore, be assessed in order to deduce the ideal means of controlling comfort levels in buildings.

The Maltese climate is characterised by hot, dry summers and mild, wet winters (Buhagiar et al., 2007), with mean temperature ranging from a maximum of 36.4°C to a minimum of 4.8°C (Galdies, 2011). Relative humidity varies from an average of 61% in July, rising to an average of 87% in January (Galdies, 2011). As a result of the climate, cooling strategies optimising ventilation are prioritised.

Climate-specific design is based on a thorough knowledge of the local context. However, in order to incorporate suitable retrofit strategies into Maltese architecture, an appreciation of the vernacular is also essential.

Originally influenced by traditional Sicilian and Arabic architecture, heritage buildings were constructed using the only available building material (limestone), and configured to address the local context (Mahoney, 1996). Characteristic features, as described by Mahoney (1996) and Cini (2006), include:

- Minimal and well-positioned external fenestration that allowed for cross-ventilation;
- Louvered apertures that were opened/closed at appropriate times to reduce glare and heat penetration;
- Central courtyard and loggia, architectural features often combined that allowed for natural light and ventilation in adjacent rooms, while also providing shading and reducing heat penetration;
- Flat roofs with *deffun*[6] configuration (additional external living space);
- Thick double-skin external masonry walls, generally measuring over 1m, which offer thermal mass and insulation through a rubble-filled cavity;
- Whitewashed internal walls, increasing natural light in internal spaces; and
- Indigenous trees and vegetation that provide shading.

These passive environmental design strategies are characteristic of vernacular architecture in other countries having similar climatic conditions; particularly in the Mediterranean region. For example, Fernandes et al. (2015) refer to the value of minimal and well-positioned apertures in maximising cross-ventilation, the high thermal mass provided by typical thick walls and the use of light colours which minimise solar gains. The internal courtyard and vegetation are also highlighted as passive cooling systems.

In the context of the Mediterranean climate, greater emphasis was placed on passive environmental control systems designed to cool interiors. Notwithstanding this, features such as the south-facing loggia maximised solar heat gain in winter. These features were supplemented by traditional practices, such as opening/closing windows/louvres at appropriate times, and removing carpets and heavy drapery in summer, to provide a comfortable indoor thermal environment.

The value of Maltese vernacular architecture lies, therefore, not only in its historical, cultural and architectural worth, but also in the potential it offers for improving comfort and reducing energy demand. Maximising the potential of passive environmental design strategies to provide comfort is core to the sustainable regeneration of built heritage.

3.7 The Presidential Palace of San Anton

3.7.1 A Context for the Case Study

The President of the Republic is the constitutional head of state, and undertakes a leading role in Maltese society. This office supports issues of national importance through constant dialogue with several sectors. The Presidential Palace would, therefore, offer an excellent means of leading the eco-refurbishment of heritage buildings by example.

San Anton Palace, Attard is the primary residence and main office base of the President of Malta. It was originally built in 1620 as a country retreat for Antoine de Paule, then Provencal

[6] *Deffun*: a traditional waterproofing system for roofs constituting a mixture of ground terracotta, lime and globigerina limestone sand (Cini, 2006).

Knight of St. John, and later Grand Master of the Order (Freller, 2009). The palace has undergone several changes over the centuries, having been restored and modified repeatedly by its residents and custodians (Soler, 2018).

Figure 3.7: San Anton Palace, Attard
(Source: A Wismayer)

This large-scale seventeenth century building (Figure *3.7*) is a multi-functional complex, catering to residential, administrative and service uses simultaneously for a population of over 100 occupants. The diversity of this working palace must merge harmoniously with the need to maintain the highest standards of heritage protection since the building is of high architectonic, cultural and historic value.

San Anton Palace was used as a case study for this research. Its complexity allows this study to generate a broad spectrum of findings which may be applied to other heritage buildings. Whilst presenting a challenging case, it is comparable in its characteristics and architectural configuration to other buildings classified within the same typology.

3.7.2 Building Features

The building is characterised by a variety of elements that are in line with Maltese vernacular architecture, and conducive to occupant comfort. Several underground reservoirs were built to irrigate the extensive grounds, having a combined capacity of 20 million cubic litres of water (Freller, 2009). The surrounding mature gardens provide shelter and shade. The building layout features several courtyards, and most rooms have high ceilings, thus prompting natural ventilation. The external walls are over one metre thick and packed with rubble, providing high thermal mass and insulation. Original finishes purposely excluded carpeting in order to mitigate the heat (Freller, 2009). Figure *3.8* illustrates some of the various passive environmental design strategies inherent to the palace.

Figure 3.8: A loggia, timber lourved apertures, thick walls and lush vegitation comprise some of the passive environmental design strategies inherent to San Anton Palace, Malta
(Source: A Wismayer)

This demonstrates that several examples of passive environmental design strategies, inherent to heritage buildings, have been integrated into the configuration of San Anton Palace. The incorporation of these traditional features is conducive to the provision of a comfortable internal environment for building occupants. However, detailed surveys and in-depth assessment is a fundamental tool in determining whether the potential of passive strategies is being maximised in this regard.

3.8 Concluding Remarks

Chapter Three contextualises this research by presenting the case study country and the case study building assessed therein. The use of Malta and San Anton Palace, Attard as case studies is justified.

Aspects relevant in meeting the aims and objectives of this work are described, including: government commitment to heritage and energy conservation; the educational programmes addressing these subjects; the legislative, policy and regulatory infrastructure tackling both issues, as well as the corresponding stakeholder groups; and climatic conditions and vernacular architecture. San Anton Palace is described in Section 3.7.

The methodology adopted throughout this study has been tailored to the context presented in this chapter. The research design, and data collection and analysis methods used to address the research aims and objectives are presented in Chapter Four.

Chapter: 4 Methodology

4.1 Introduction

This chapter describes the methodology designed to address the research aims and objectives outlined in Chapter 1. The systematic mixed-method approach is explained, and its merits justified against other techniques. The selected data analysis procedures are also presented.

4.2 Research Design

Research methodologies comprise both data collection and data analysis techniques, and may be qualitative or quantitative in nature (Chu and Ke, 2017). Whereas quantitative research converts uniformities into numerical form against which a hypothesis may be tested, qualitative techniques aim to derive a rich and in-depth understanding of social action (Feagin et al., 1991). This study adopted a mixed methodology to gather and analyse data, as advocated by several researchers (e.g. Kong et al., 2018; Flyvbjerg, 2006; Fonseca et al., 2015; Morse and Neihaus, 2009). The research design combined qualitative and quantitative methods, based on a triangulation approach (Olsen, 2004; Neuman, 2006).

The epistemological position taken up in this research is that of positivism. Based on the principle of phenomenalism, positivism entails a deductive approach and inductive strategy, advocating the role of research to test theories and enable the development of laws in a manner that is value free and which distinguishes between scientific and normative statements (Bryman, 2001). The study seeks to test a hypothesis, using deductivism and inductivism, in an objective and scientific manner.

The ontological position taken up in this research is that of constructionism. Also referred to as constructivism, it is based on the assertion that social categories, such as culture, and their meaning, are produced by social interaction, and are continuously revised (Bryman, 2001). The impact of occupant behavior is a primary concern of this study, which is founded on the premise that the benefits of a user-centric approach are invaluable.

The research was undertaken in two overlapping phases. A case-specific study, focusing on the Presidential Palace of San Anton in Attard, informed a subsequent wider assessment targeting key stakeholders in the field. The case-study analysis included an in-depth architectonic assessment, occupant surveys, a semi-structured interview and environmental monitoring, bolstered by a desk study. The initial deductions from the first phase of research informed the wider study, which included the delivery of two workshops, a structured questionnaire and a semi-structured focus group. Ethics approval was sought and achieved before any of the participant-centric research methods were implemented.

The following sections describe the case-specific approach (Section 4.3) and the wider study (Section 4.4). The data analysis methods are then presented in Section 4.5.

4.3 Case-Specific Study

A commonly utilised and widely accepted research tool, the case study allows for lessons to be drawn and theories to be generated through an intensive analysis of a single case (Stake, 2005; Flyvbjerg, 2006). In its fundamental form, it is generally understood as comprising a comprehensive audit of a specific community, school, family, organisation, person or event (Bryman, 2001). For the purpose of this research, the term 'case study' is defined as an in-depth examination of various facets of a single building, using both qualitative and quantitative methods. The case study method has been adopted by several researches in the examination of listed or heritage buildings (e.g. Ascione et al., 2015; Ben and Steemers, 2014; Ceroni et al., 2015; Fabbri and Pretelli, 2014).

The case-specific study centred on the presidential palace of San Anton in Attard, Malta, with the scope of addressing the Research Aim 1:

To determine whether the inherent potential offered by passive environmental design strategies at San Anton Palace is being compromised.

As advocated by Tellis (1997), the complex nature of this building, described in Section 3.7, allowed for maximum learning in minimal time. The lessons learnt through an investigation of the palace may be applied to other heritage buildings, as has been shown to be possible by Flyvbjerg (2006).

It is recommended that, when adopting the case study methodology, multiple data sources are used as a means of ensuring reliability (Feagin et al., 1991). In the analysis of San Anton Palace, data was gathered through:

- Architectonic assessment (Section 4.3.1.);
- Desk study (Section 4.3.2.);
- Occupant survey and semi-structured interview (Section 4.3.3.); and
- On-site monitoring of environmental parameters (Section 4.3.4.).

These methods have been described in detail below.

4.3.1 Architectonic Assessment

The architectonic assessment of San Anton Palace is in line with Objective 1A of this research:

To assess the architectonic characteristics of San Anton Palace, and whether past interventions on the building fabric impact occupant comfort and environmental performance.

It comprised a field investigation based on first-hand observation of the case study. This method is advocated by the CEN standard on improving energy performance in heritage buildings (EN16883: 2017). The assessment was conducted through several site visits with the objective of gaining:

- An understanding of the architectonic qualities of the Palace, and the vernacular techniques utilised in its planning and construction; and
- Insight into the factors influencing indoor environmental conditions.

The comprehensive architectural study of the building fabric and use was undertaken through a detailed survey of each room. All passive environmental design strategies and inherent characteristics, which directly or indirectly impact the energy profile of San Anton Palace, were systematically recorded. The elements considered are described below:

Lighting: Accounting for between 5% and 15% of total electricity use, lighting is one of the major energy consumers in buildings (Yun et al., 2012). Therefore, the study included a detailed account of the artificial lighting system in each room. This included a record of the fitting type and layout, and the type and number of bulbs for each fitting.

Figure *4.1* illustrautes, in part, the lighting system in one of the States Rooms at San Anton Palace.

Figure 4.1: Chandelier and floor lamps in the Grandmasters Suite, San Anton Palace
(Source: A Wismayer)

Apertures: Studies have shown that the design of apertures is integral in ensuring visual comfort and reducing reliance on artificial lighting (Acosta et al., 2016; Ghisi and Tinker, 2005). This is also true in the provision of natural ventilation (Heiselberg et al., 2001; Stavrakakis et al., 2012). Therefore, the type (door or window) and nature (internal or external) of all apertures were recorded, as were their materials (timber, aluminium, single/double glazing) and opening mechanism. The presence, type and nature of all accessories (shutters, blinds, curtains) were also surveyed and recorded.

HVAC system: Reliance on heating, ventilation and air-conditioning (HVAC) systems has increased in southern European countries, and is now considered to be the largest energy consumer in buildings (Perez-Lombard et al., 2008). For the purposes of this study, an HVAC system is defined as any system used to artificially heat or cool a room, including air-conditioning units, floor fans and fireplaces. The existing HVAC system of each room was recorded, including type and quantity. The status (on or off) at the time of inspection was also noted.

Orientation: Orientation has been referenced as one of the most important parameters in the passive solar design of buildings, and one which influences energy demand (Pacheco et al., 2012). The orientation of each room was, therefore, recorded in the building survey.

Material of Surface: The material (e.g. marble, flagstone, timber etc.) and finish (e.g. painted, fair-faced masonry etc.) of all surfaces (floors, walls and ceilings) was listed. Where surfaces were not entirely visible, any assumptions made were clearly stated. Figure *4.2* depicts typical flooring and wall finishes at San Anton Palace.

Figure 4.2: Flagstone flooring and painted walls, San Anton Palace
(Source: A Wismayer)

Basements and Intermediate levels: Access to underground spaces and intermediate levels, as well as the presence of apertures/vents, were recorded.

Passive Environmental Design Strategies: Passive environmental design strategies inherent to San Anton Palace were identified through the architectural assessment of the case study. The identification process was carried out using first-hand observation during site visits and a detailed review of the layout plans.

Room Use Survey: For the purpose of this research, primary room use refers to the evident and predominant use of each room. These were identified through a room use survey of the case study building. Secondary uses were also identified through observation and interviews with building occupants.

On-going/Proposed Changes: A survey of works at San Anton Palace was undertaken. Alterations that were being carried out during the assessment, as well as works planned for the future, were identified through first-hand observation during site visits and meetings with the logistics team.

Additional Details: For the purpose of the building survey, each room was given a reference name and nomenclature within the general room-use classification, for example: Gold Suite / GS.L01 / State Room. The date and time of access was also recorded.

4.3.2 Desk Study

A desk study was conducted to assess how San Anton Palace was altered since its initial construction in the early 17th century. This also allowed for a better understanding of historical and cultural significance of the building. The study comprised an assessment of information from existing literature sources through secondary data collection. It is also in line with Objective 1A of this research.

Walliman (2017) defines secondary data as data that have not been gathered directly by the researcher. The analysis of secondary data involves empirical assessment, based on a systematic research process (Johnston, 2014). It is a useful tool, offering several advantages including but not limited to time and cost efficiency, and few limitations such as lack of familiarity with data (Bryman, 2001).

4.3.3 Occupants

The interview is a widely used research method in both qualitative and quantitative studies (Bryman, 2001). There are various forms of research interviews. As part of the case-specific study, the structured interview and the semi-structured interview were adopted as data gathering techniques. These are in line with Objective 1B of this research:

To evaluate the attitudes, perceptions of comfort and functionality, and environmental behaviour of occupants at San Anton Palace.

4.3.3.1 Structured Interviews_ Occupants

The structured interview was selected as a method of gathering data from occupants of San Anton Palace. This form of interview, in which an interview schedule is administered by the researcher, minimises errors resultant from variability through the standardisation of questions (Bryman, 2001). A variety of closed and open-ended questions were included in the schedule. The latter allow respondents to express their opinions freely and discuss related topics.

A series of structured interviews with palace occupants and users were undertaken in order to assess their perception of comfort, functionality, satisfaction and expectation in the context of the building's existing use framework and layout. Approximately 33% (n=35) of the total sample set of 105 residents and staff were interviewed. The information gathered from participants with first-hand experience of the palace, proved vital in assessing comfort levels and analysing the impact of user behaviour on energy demand. Moreover, it supported the selection of rooms to be monitored.

Participant Selection

In order to derive relevant data from persons familiar with the case study, participants were selected through a process of random sampling of stakeholders: several of the stakeholders living and working at the palace were asked to participant, and those who were available sat for the interview. Participant selection was informed by the aim and objectives of the research exercise, as well as the case study to be analysed (Ritchie et al., 2003).

Designing the Interview Schedule

The structured interview schedule comprised both open-ended and closed-ended questions. It was designed with the following objectives:

- Collect pertinent information on the occupants' perception of comfort, functionality, satisfaction and expectation in the context of the case study building;
- Define clear questions that do not probe, prompt or lead the respondent; and
- Minimise the duration of the interview in order to reduce inconvenience to participants.

The questions were designed to obtain specific data, as outlined in Table *4.1*: Relevance of questions in interview schedule for occupants of San Anton Palace.

Table 4.1: Relevance of questions in interview schedule for occupants of San Anton Palace

Question	Justification	Analysis
Q1	Contextualise the responses to subsequent questions by establishing the role and responsibilities of participant.	Participant-centric.
Q2	Benchmark the participant's duration of experience at San Anton Palace.	Participant-centric.
Q3	Establish a history of the user's experiences of changes at San Anton Palace.	Participant-centric.
Q4	Provide an index of the rooms flagged by participants.	Room-based.
Q5	Assess specific criteria for each room based on the respondent's experience.	Room-based.
Qs6-8	Provide more detailed reflections on comfort and functionality in terms of the room layout, furnishings, doors, windows and fenestration design.	Room-based.
Q9	Appraisal of participant's general perception of comfort at San Anton Palace.	Participant-centric.
Q10	Appraisal of participant's general perception of functionality at San Anton Palace.	Participant-centric.
Q11	Allows respondents to express opinions .	Participant-centric.

A clear and consistent understanding of the questions was ensured through consultation with an expert in the field of behavioural psychology. In addition, as recommended by Bryman (2001), pilot interviews were conducted with three respondents representing different occupant groups, namely administrative staff and service staff. The interview schedule and the method of conducting the interview were amended based on the feedback received from the behavioural psychology expert and the results of the pilot interviews.

The revisions are outlined hereunder:

- Rather than reading the introductory statement to participants, the researcher provided respondents with a hard copy and allowed them the time to read through it at their own pace. Once, they had done so, the researcher asked whether any clarification was required prior to proceeding with the interview.
- During the pilot interviews, participants found it difficult to recall scale references in questions where it was required to rate comfort levels. Therefore, a copy of the scale bar was made available to the respondents during subsequent interviews for their reference.
- The pilot study highlighted the need to clarify the words/phrases, for example, the difference between comfort and functionality. Definitions were, therefore, provided as an annex that participants were given beforehand. As a result, all respondents were provided with the same briefing and definitions in order to ensure consistency in the respondents' understanding of these terms.

The final interview scheduled is provided in Appendix A.

An adaptation of the Likert scale was used to investigate the occupants' perception of comfort at San Anton Palace. The five-point (or seven-point) Likert scale is well-established in psychological surveys (Bryman, 2001). The term 'comfort' was not restricted to thermal comfort in order to identify pertinent issues relating to occupant comfort in heritage buildings using the case study.

Conducting the Interview

An introductory statement was read to participants prior to the interview in order to:

- Introduce and explain the research, giving participants a sense of ownership; and
- Ensure a consistent understanding of terminology amongst participants.

To contextualise the data, air temperature and relative humidity were recorded during the interviews in order to frame the comfort levels discussed by the respondents. These were recorded using a portable data logger of accuracy +/- 0.1°C and ±3%, and resolution 0.1°C and 0.1% relative humidity. Reading were taken every 5 minutes.

4.3.3.2 Semi-Structured Interviews_ The President

Schultze and Avital (2011) define the qualitative interview as a technique used extensively in qualitative research across several fields. Semi-structured interviews generally comprise a set of pre-defined open-ended questions, with additional follow-up questions derived during session as a result of the discussion (DiCicco-Bloom and Crabtree, 2006). Bryman (2001) adds that deviating from the questions as outlined on the schedule is acceptable in this approach.

A semi-structured interview with the sitting President, Her Excellency, Marie-Louise Coleiro Preca (2014-2019), was undertaken with the aim of gaining an understanding of her perceptions of comfort and functionality, as a resident at San Anton Palace. The interview was also used to garner information regarding the way in which the building was adapted and used during her term.

Designing the Interview Schedule

Contrary to structured interviews, the semi-structured format may include prompts, which will direct a dialogue on and around the topics outlined in the schedule, allowing for themes which the researcher may not have identified to be discussed (Galvin, 2015). The interview guides, included as Appendix B, comprised a series of questions to be asked and issues to be addressed. As recommended by Bryman (2001), the design allowed for the:

- Topic areas to be ordered, establishing a flexible flow of questions;
- Research questions to be addressed; and
- Respondents to easily comprehend the terms and language used.

4.3.4 On-Site Monitoring of Environmental Parameters

On-site environmental monitoring equipment was installed at San Anton Palace between November 2016 and March 2019. Over this period, data sensors, developed by the University of Bath, logged air temperature, relative humidity and carbon dioxide at five-minute intervals. The instruments used were in line with EN ISO 7726: 1998, an international standard that tabulates recommended basic technical information, such as ideal sensor accuracy and resolution.

This methodology is in line with Objective 1C of this research:

To identify use-related barriers to environmental monitoring in heritage buildings.

Guerra-Santin and Tweed (2015) advocate long-term monitoring when the aim of the exercise is to develop an understanding of the building's environmental performance over a longer period, for example a number of seasons or a year. Therefore, in line with the objective of this research, the data loggers were intended to measure parameters for at least twelve months. However, given the difficulties encountered during the monitoring process (outlined in Section 5.5), it was decided to continue monitoring for as long as access to the case study was available in order to:

- collect as much data as possible; and
- further the analysis of the impact of user interference and logistical issues on the monitoring process, and the development and validation of best practice guidelines, as described in Section 7.2.7.

The results of the architectonic assessment of San Anton Palace (Section 4.3.1) and the structured interviews with occupants (Section 4.3.3.1) provided the basis for the selection of rooms to be monitored. Consequently, the monitoring began once the results of both had been studied.

Sixteen monitors recorded data in six rooms within two sections of the palace as described below:

- Case 1: Four offices at ground floor; and
- Case 2: Two guest rooms at first floor.

Both suites of rooms were frequently referenced by the participants of the occupant survey: therefore, data on the users' perspectives on the levels of comfort, satisfaction and functionality of these spaces was readily available. The architectonic assessment of the rooms provided rich data that aligned with the results of the occupant surveys. The selection allowed for two suites of rooms having two distinct uses to the assessed (Case 1: office / Case 2: primarily temporary accommodation). Moreover, the multi-functionality of both these spaces, as well as the high level of use and users, aggrandised the challenging nature of study: consequently, the lessons learnt from the analysis were expected to be widely applicable.

The rooms that were monitored are depicted on layout plans in **Error! Reference source not found.** and Figure *4.4*. The plans were produced by the Works and Infrastructure Department Project Design and Engineering Directorate at the request of Her Excellency, and adapted by the author in Figures 4.3 and 4.4.

Figure 4.3: Data loggers were installed in offices (rooms A-D) at ground floor level

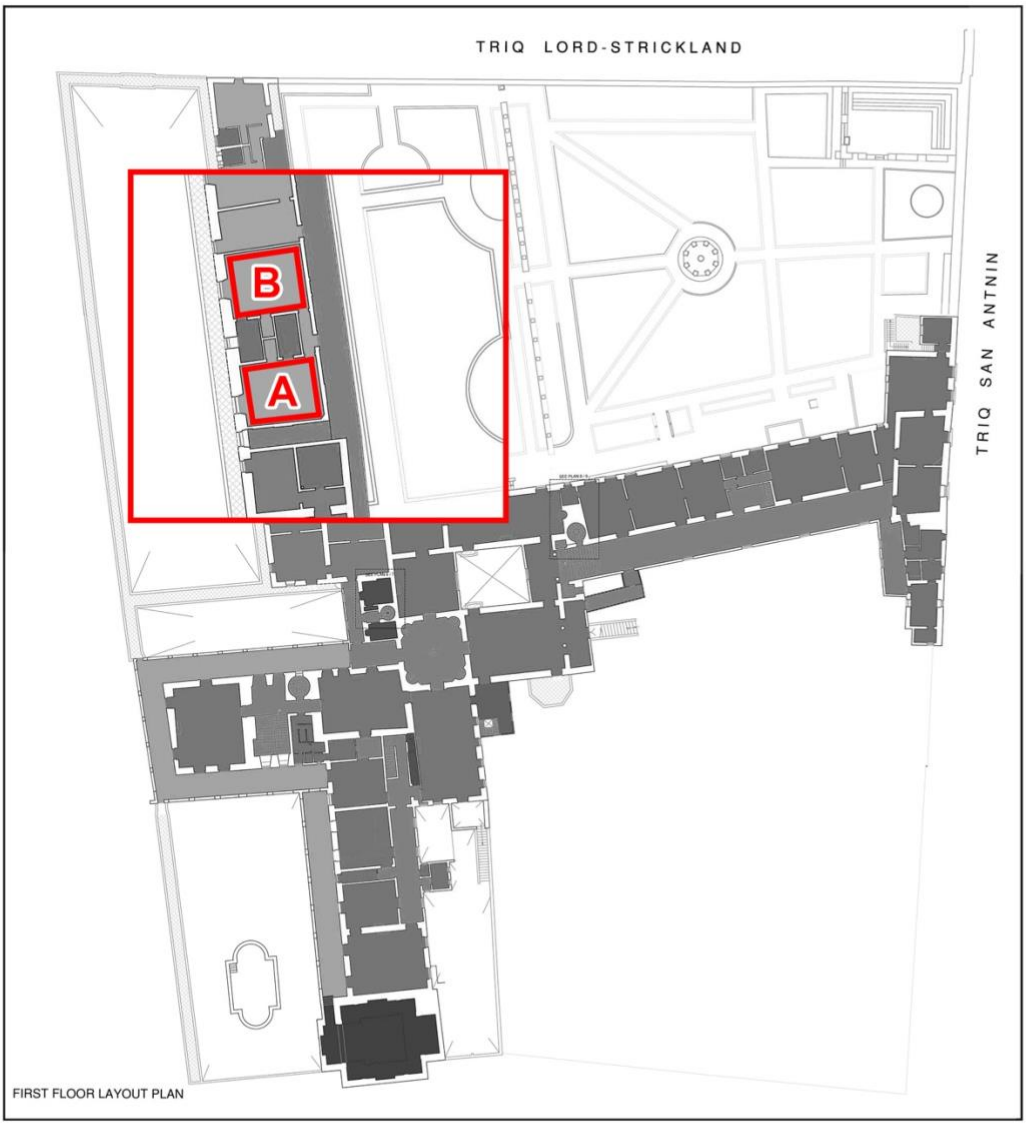

Figure 4.4: Data loggers were installed in guest rooms (rooms A and B) at first floor level

The building performance monitoring undertaken was both diagnostic and investigative in nature. Guerra-Santin and Tweed (2015) define diagnostic assessments as being designed to improve building performance, whereas investigative assessments outline lessons for the future.

As recommended by Bryman (2001), incidents were systematically recorded upon being observed. Following reflection and discussion with key stakeholders in the occupants/user population at San Anton Palace, the monitoring procedure was amended slightly to avoid reoccurrence. The success of the change served as a means of validating the system.

4.4 Wider Study

In order to develop an effective strategy for the sustainable regeneration of heritage buildings in Malta, the contributions of a wide network of local stakeholders were required. This is in line with Research Aim 2:

To examine the different aspects of the sustainable regeneration of built heritage in Malta and whether these support the sensitive, adaptive re-use of historic architecture.

The wider study targets the Objectives 2A-C of this research:

To evaluate the public's perceptions of the sustainable regeneration of built heritage and heritage buildings in Malta, and the level of awareness regarding the applications of passive environmental design strategies.

To appraise the knowledge base, and level of awareness of stakeholders involved in designing and assessing interventions on heritage buildings.

To determine whether the existing regulatory framework targets and supports all relevant parameters in the design and assessment of heritage building interventions.

As advocated by several researchers (Olsen, 2004; Fonseca et al., 2015; Morse and Neihaus, 2016; Kong et al., 2018), a mixed methodology was used to gather data. This is outlined in Table *4.2*, which specifies the actions taken and research tools utilised in this research. The overall approach consisted of the delivery of two workshops, a structured questionnaire and a semi-structured focus group, each targeting specific participants.

Table 4.2: Summary of Data Gathering Methods

Actions	Research Tools	Participants
Event A_ Stakeholders Workshop 19th September 2016	Workshops (x3)	Participants (N=66) included: policy-makers, regulators and operators; professionals; academia; non-governmental organisations.
Event B_ Public Seminar 4th April 2018	Questionnaire	Participants (N=51) comprised a self-selecting sample of the public representative of different demographic groups.
Event C_ Planning Authority Workshop 5th June 2018	Workshops (x2)	Participants (N=12) were selected by senior management and represented various departments within the Planning Authority.
Event D _ Stakeholders Focus Group 30th July 2018	Focus Group	Participants (N=3) represented the: Faculty for the Built Environment; Chamber of Architects and Civil Engineers; Building Regulations Office.

Participants of the Event B (N=51) were self-selecting, responding to a general invite distributed through various channels. The size of the sample was not representative of the country's population. Moreover, it may be assumed that those who responded to the invitation have a pre-existing interest in either heritage buildings or environmental performance, or both. However, according to Bryman (2001), a representative sample may be defined as:

"a sample that reflects the population accurately so that it is a microcosm of the population".

As described in Section 6.2.1.1, the sample was found to be in line with Bryman's definition in that both gender and age groups were well represented.

The participants of Events A (N=66), C (N=12) and D (N=3) were specifically selected and personally invited as a result of their expertise and/or particular professional standing in their field of the industry. The selection process comprised the identification of informed decision-makers who are in a position to implement change.

Workshops (Section 4.4.1) are a robust instrument for attaining the intimate involvement of stakeholders (Street, 1997) across a range of disciplines. Quist and Vergragt (2000) have demonstrated the success of workshops as a participatory method which enables the opinions, attitudes, perceptions and values of diverse groups to be registered, and allows for ideas to be developed harmoniously.

A questionnaire (Section 4.4.2) was chosen since it offers the opportunity to collect a large amount of data from the targeted respondents quickly. Provided that the researcher is present and available in case of issues or queries, self-administered questionnaires allow participants to answer questions at their own pace but within the allocated time. Moreover, the generated data is free of interviewer variability and interviewer effects which, as suggested by Tourangeau and Smith (1996), may yield bias responses.

The focus group technique (Section 4.4.3) is a method of interviewing a group of respondents simultaneously (Bryman, 2001). Morgan (1998) recommends smaller groups in instances when participants are well versed in the topic, as is the case for the respondents interviewed in this study. In this case, it was considered more appropriate than a group interview since it is designed to address a specific topic. It was also felt to be more appropriate than individual interviews since it allows for a discussion which may challenge the respondents and strengthen the quality of data generated. Although Bryman (2001) notes that multiple focus group sessions are typically held, the single session hosted as part of this research targeted a specific group of respondents whose views were particularly valuable to the study. It was, therefore, sufficient to hold one focus group. Given that the participants of the focus group were specific selected on their skill set, piloting in a representative focus group setting presented difficulties. However, the questions were put to a professional with a general understanding of the issues at hand in order to test their clarity. No amendments were necessary.

Ethics approval was obtained prior to engaging with any of the participants.

4.4.1 Workshops_ Events A and C

Workshops were used to establish the perspectives and experiences of key stakeholders in the sustainable regeneration of built heritage. Two semi-structured workshops were held in sequence (Events A and C), with the former informing the latter. The first was used to address a range of stakeholders. Of these, the Planning Authority was identified as necessitating further in-depth investigation. Therefore, the second workshop was specifically targeted at Planning Authority representatives.

In both cases, the workshop sessions were preceded by presentations, and a study tour of San Anton Palace, contextualising the research. The content of the presentations mainly referenced the value of heritage buildings and the potential of inherent passive environmental design strategies in promoting occupant comfort and reducing energy demand. This research (background, results, conclusions as relevant) was also included.

The stakeholders workshop featured a panel discussion on the wider concepts of sustainability and heritage buildings, which presented the perspectives of different entities, including the Planning Authority, non-governmental organisations, academia and the profession. The Planning Authority workshop featured an informal discussion, designed to establish the knowledge base and perceptions of the Authority on the concepts of heritage and energy conservation.

The aim of the Stakeholders Workshop (Event A) was to establish the knowledge base and awareness levels of key players in the eco-refurbishment of heritage buildings in Malta, and explore the issues faced in designing, proposing and implementing interventions. Three workshop sessions, run simultaneously, focused on the:

- Eco-refurbishment of heritage buildings;
- Sensitive interior design of heritage buildings; and
- Effect of passive environmental design strategies on the environmental performance of heritage buildings.

The Stakeholders Workshop involved a varied group of local participants comprising various key stakeholders. The participants (N=66) included representatives of the following organisations/groups:

- Ministry for Sustainable Development, the Environment and Climate Change;
- Building Industry Consultative Council;
- Faculty for the Built Environment and Faculty of Engineering, University of Malta;
- Institute for Climate Change and Sustainable Development, University of Malta;
- Planning Authority and Building Regulations Office;
- The Profession (Architects and Civil /Structural Engineers); and
- Product Suppliers.

The objective of the Planning Authority Workshop (Event C) was to develop an understanding of the procedures and best practice guidelines adopted by the Planning Authority, as well as the obstacles faced in relation to interventions on heritage buildings. Two workshops were run simultaneously. The participants (N=12) of each session were selected on the basis of their role within the Authority. The groups, which were divided into senior management and on-the-ground operators, addressed similar topics from different perspectives. The aspects being discussed included the:

- Availability and adequacy of existing policy, guidance documents and best practice standards;

- Direction adopted by the Planning Authority with regards to heritage buildings and environmental design;
- Attitudes of the applicants / perit[7] towards this building typology, as experienced by the Planning Authority;
- Obstacles faced by the Planning Authority; and
- Recommendations to facilitate the Planning Authority's assessment of heritage building applications.

4.4.2 Public Questionnaire_ Event B

The public seminar targeted the general public, a key stakeholder in the sustainable regeneration of built heritage. The participants comprised of a self-selecting sample of the general public with an interest in heritage buildings and/or energy efficiency.

The primary scope of the session was to derive an understanding of the respondents' knowledge base in the context of the field of research. The event was also designed as a means of disseminating information. To this end, after completing the questionnaire, respondents attended an information seminar and a tour of the case study building, designed to inform participants of the benefits of passive environmental design strategies inherent to heritage buildings.

The questionnaire was divided into two sections. Section A was completed prior to the seminar and Section B, which incorporates questions repeated from Section A, was completed after the seminar. This was done in order to determine whether the information disseminated throughout the seminar would alter the respondents' views.

The questions were designed with the scope of:
- contextualizing the respondents (Questions A1-4);
- identifying a preference for heritage or contemporary buildings (Questions A5 and B1);
- establishing the participants' perspective on conservation and regeneration of heritage buildings (Question A6);
- identify prevalent issues commonly associated with heritage buildings (Question A7);
- assessing respondents' perspectives and understanding of heritage buildings (Questions A8-12, A17 and B2); and
- assessing respondents' awareness and understanding of passive environmental design strategies (Questions A13-16 and B4-6).

The questionnaire was piloted with four respondents, two aged between 30 and 37, and two aged between 65 and 68. Having assessed the results and discussed the questions with the participants post-questionnaire, it was determined that no changes were required.

Ethics approval was obtained prior to engaging with any of the participants.

The questionnaire is presented in Appendix C.

[7] Perit: title of warranted architect and civil or structural engineer in Malta (Kamra tal-Periti, 2018b)

4.4.3 Focus Group_ Event D

A single focus group session was held for key stakeholders in the sustainable regeneration of Malta's built heritage, during which one representative from each of the organisations listed in this section participated collectively in a semi-structured interview. The fluid interview schedule comprised of a few general questions designed to guide the session, as recommended by Bryman (2001).

The aim of the focus group was to discuss specific themes and issues arising from both workshops and the public questionnaire, in a setting where participants' interactions may be observed. The session was particularly informed by the Planning Authority Workshop, which identified the following stakeholders as having a key role in the sustainable regeneration of built heritage:

- The Faculty for the Built Environment, University of Malta**:** As the sole provider of the educational training and degree necessary to graduate as an architect and civil engineer in Malta, the Faculty for the Built Environment (University of Malta) plays an integral role in defining the existing knowledge-base of students and graduates. During the stakeholders focus group, this entity was represented by a senior member of the Faculty;
- The Malta Chamber of Architects and Civil Engineers**:** The Chamber of Architects and Civil Engineers supports members of the profession in their practice in the interest of the community (Kamra tal-Periti, 2018c). The Chamber advocates for the protection of Malta's architectural heritage and for the formulation of a local Building Regulations framework (Kamra tal-Periti, 2019b). During the stakeholders focus group, the Chamber was represented by a council member; and
- The Building Regulation Board, Malta: Amongst other responsibilities, the Building Regulation Board is entrusted with the preparation of technical guidance documents (Building Regulation Office, 2018). This may include a national framework for environmental performance requirements in buildings. The Building Regulation Board was represented at the stakeholders focus group by a board member.

4.4.4 The Courtyard Case

During the workshops and the focus group, the Courtyard Case was presented to participants.

The case example, developed by Wismayer (2013), is outlined below:

The Courtyard Case
"Consider a typical vernacular courtyard house, that has been abandoned and disused. The property is purchased by a young couple, who want to the convert the house into a residence. Since the stairs to the first floor are located externally in the courtyard, as is characteristic of this building typology, the conversion proposal submitted to the Planning Authority includes the structural removal a few stone slabs from one of the ceilings to create an internalised access to the first floor."

Case Example 4.1: The Courtyard Case

The courtyard house case presents a scenario typical of the Maltese context (Wismayer, 2013). The interventions as proposed may impact on heritage value, however, the alternative, of roofing the courtyard to internalise the staircase (Figure *4.5*) may impact on environmental performance.

Participants were requested to comment on the case, and encouraged to give their viewpoints on how it should be assessed. This was done as part of the wider study with the scope of evaluating whether stakeholder groups adopt different approaches to the same case.

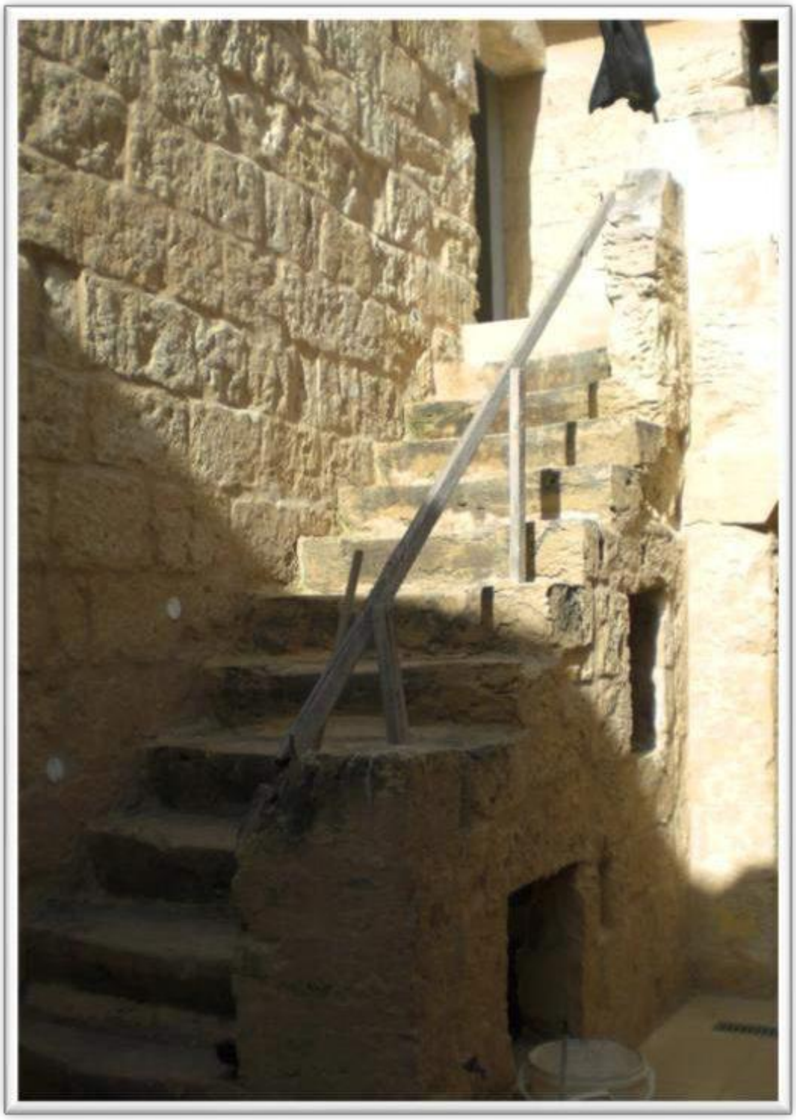

Figure 4.5: Staircase in courtyard providing externalised access to the first floor (Wismayer, 2013)

Figure *4.6*,
Figure *4.7*,

Figure *4.8* and
Figure *4.9* illustrate drawings of the courtyard house referenced in Case Example *4.1*. The building is a typical example of vernacular architecture in Malta, featuring several inherent passive environmental design strategies, such as thick walls, externally ventilated basements, a south-facing loggia and courtyard, as well as vegetation.

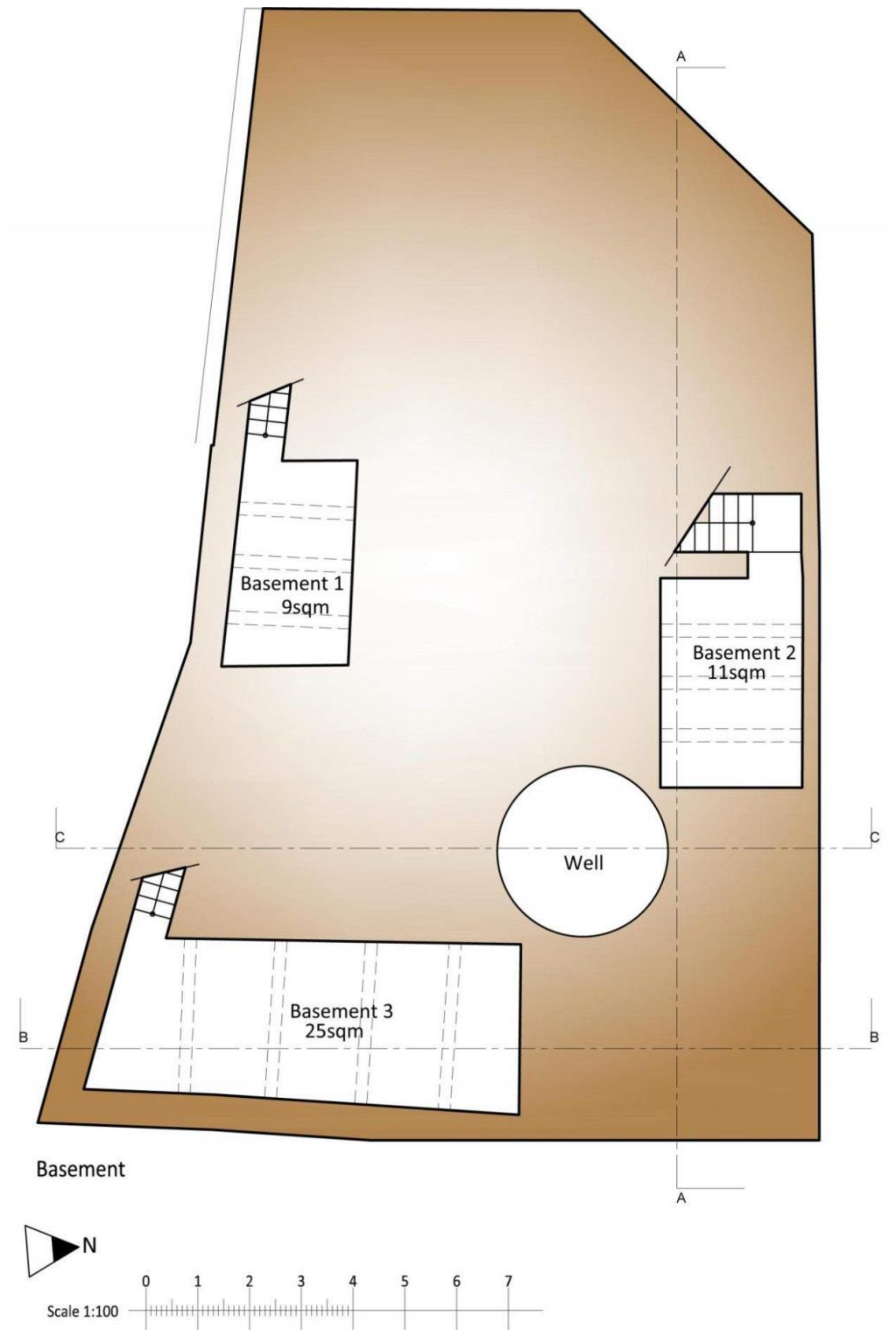

Figure 4.6: Basement layout plan
(Wismayer, 2013)

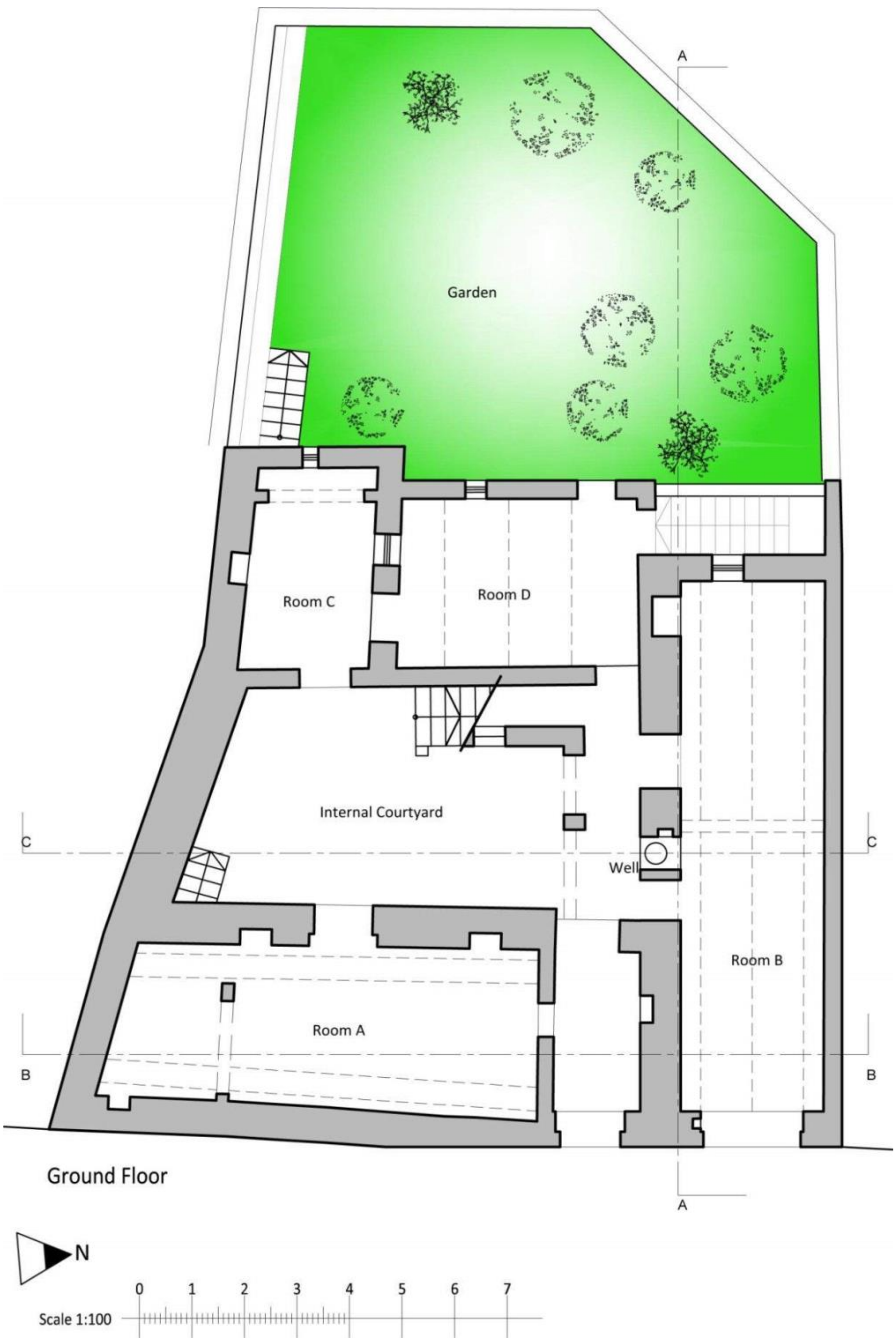

Figure 4.7: Ground floor layout plan
(Wismayer, 2013)

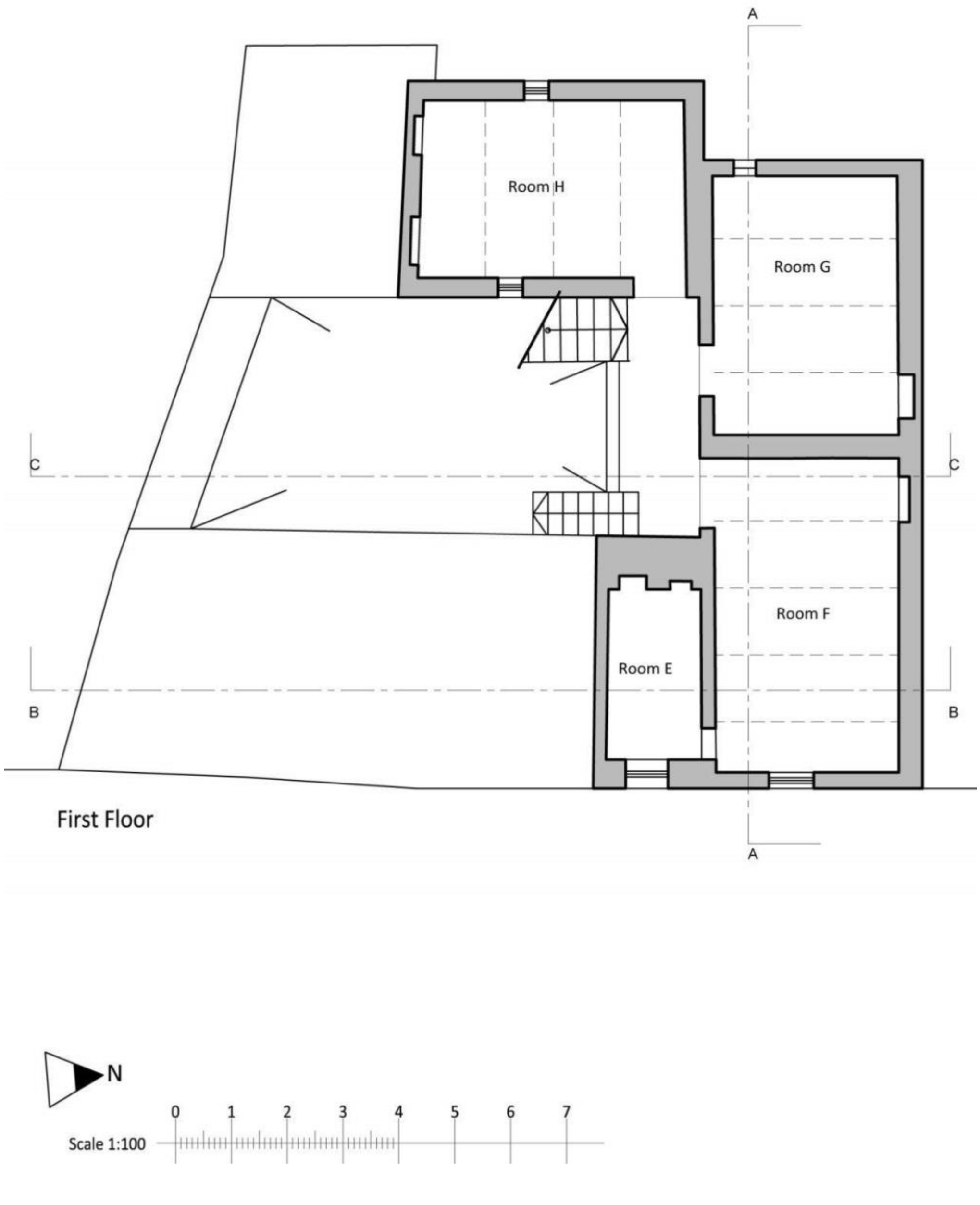

Figure 4.8: First floor plan
(Wismayer, 2013)

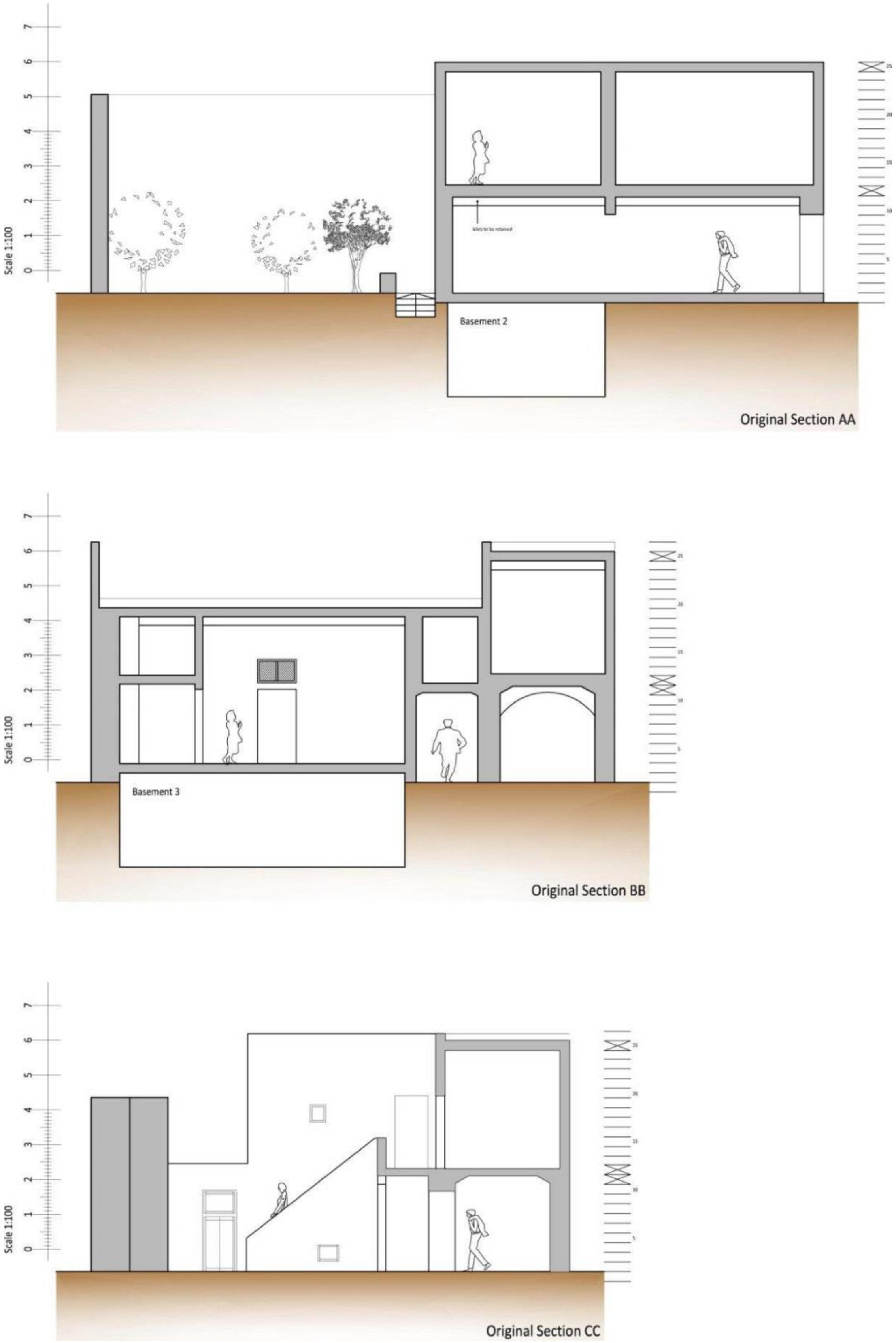

Figure 4.9: Sections corresponding to layout plans
(Wismayer, 2013)

Apart from the Courtyard Case (Case Example *4.1*), which is explained in this section, the Case Examples introduced in Chapter: 6 were presented by participants of the stakeholders workshop, the Planning Authority workshop and the focus group, as tangible examples. The cases were found to be of practical relevance to the wider study in that they highlight the shortfalls and failings of the existing infrastructure. The lessons learnt from a thorough understanding of these cases were applied in the development of a prototype to support the sustainable regeneration of built heritage, described in Section 7.6.

4.5 Data Analysis Methods

4.5.1 Qualitative Data Analysis

Qualitative data analysis addresses data generated by people as a focus of the research, either individually or in groups (Walliman, 2017). Content Analysis was used to assess the complex, qualitative data generated through the semi-structured interview, workshops, public questionnaire and focus group. The approach comprises the systematic and replicable distribution of information into defined categories (Bryman, 2001; Dawson, 2012). It is a transparent and reliable method, allowing the researcher to carry out rigorous data analysis and derive practical conclusions (Assarroudi et al., 2018). It is also a highly flexible approach, which may be applied to a wide selection of documents (Scott, 1990).

Three approaches to content analysis have been identified, namely: conventional, directed and summative (Hsieh and Shannon, 2005; Assarroudi et al., 2018). Of these, directed content analysis was adopted as the primary means of data analysis for the purpose of this research, and applied to the results of Events A, C and D. Conventional content analysis was adopted within a mixed-method approach, to assess the results of Event B.

The results of the environmental monitoring process were also assessed qualitatively using unstructured observation. Unstructured observation is a technique which enables the researcher to observe and record the participants' behaviour in an unscheduled manner in order to develop a narrative (Bryman, 2001). In this study, the behaviour of the occupants and users of San Anton Palace was observed and recorded in order to identify the user-related challenges associated with the environmental monitoring of in-use buildings, and design best practice guidelines. The recorded incidents where analysed using content analysis.

4.5.2 Quantitative Data Analysis

Quantitative data analysis assesses data numerically, utilising a mathematical approach (Walliman, 2017). Quantitative data analysis was used to assess the responses of the structured interviews with occupants, and the public questionnaire. Numerical comparisons were performed, both manually and using SPSS, in order to understand respondents' perceptions and knowledge base. In the case of the public questionnaire, numerical comparisons were also used to ascertain whether the dissemination of information triggered a change in this regard.

The quantitative analysis of the questionnaire results was carried out in three stages, as described below:

- Stage 1_ General Analysis: The results generated by each question were analysed individually, and then collectively, to produce an overall assessment of the data;
- Stage 2_ Demographic Context Analysis: The results generated by each question were analysed in the context of the participant demographics (age, level of education, experience of heritage buildings) in order to determine whether these affected the data from this group of respondents; and
- Stage 3_ Comparative Analysis: The responses to questions in Section B were compared to those generated by the same questions in Section A to ascertain whether the information disseminated triggered a change in responses.

The primarily quantitative method of analysing the data generated through the questionnaire was paired with an element of qualitative content analysis. The responses to open-ended questions were coded in order to enable the interpretation of a general meaning.

4.6 Concluding Remarks

This chapter presents the research design developed to address the research aims and objectives of this study, citing literature and experts in the field. The systematic mixed-methodology based on qualitative and quantitative data collection and analysis methods is explained, and its merits justified against alternative techniques.

The methods are summarised in Table *4.3*.

Table 4.3: Summary of the methods utilised throughout this research

Study	Objective	Data Collection	Nature of Data
Case-Specific Study	1A	Architectonic Assessment	Qualitative & Quantitative
	1A	Desk Study	Qualitative
	1B	Occupant Survey	Qualitative & Quantitative
	1B	Semi-Structured Interview	Qualitative
	1C	Environmental Monitoring	Qualitative
Wider Specific	2A-C	Workshops	Qualitative
	2A & 2B	Questionnaire	Qualitative & Qualitative
	2B & 2C	Focus Group	Qualitative

Each step in the process is outlined, including the design and piloting of any interview / questionnaire / focus group schedules, all of which are included in the appendices. Case examples are utilised to aggrandise the data gathered and understand the practical implications of the results: the sourcing and application of these are explained.

The results gathered using the methodology outlined are presented in Chapter Five.

Chapter: 5 Results and Analysis of the Case-Specific Study

5.1 Introduction

This chapter presents the findings of the case-specific study, undertaken to address Research Aim 1:

To determine whether the inherent potential offered by passive environmental design strategies at San Anton Palace is being compromised.

Utilised as the primary residence and main office base of the President of Malta, San Anton Palace (hereafter referred to as SnAP) is a building of great historic, cultural and architectural value. A detailed case-specific study of the building (Figure *5.1*) was undertaken as part of this research. As described in Section 4.3, the evaluation included an architectonic assessment, a desk study, an occupant survey and semi-structured interview, as well as on-site monitoring of environmental parameters.

Figure 5.1: View of San Anton Palace
(Source: A Wismayer)

European guidelines for improving the energy performance of heritage buildings were published in 2017 (EN16883:2017), after the architectonic assessment and occupant survey at SnAP had been finalised, and the environmental monitoring was underway. However, the procedure adopted during this research was in line with this standard, in that it included a building survey, and a study of user behaviour.

The results, presented in this chapter, highlight the highly complex nature of the building (Section 5.2) and the occupants' perceptions of comfort and functionality (Sections 5.3 and 5.4). The importance of engaging building users in the assessment process is also emphasised through the findings (Section 5.5).

5.2 Architectonic Assessment

A detailed architectonic analysis was carried out to understand the architectural configuration of the case study (PEDS; building fabric and finishes; environmental control mechanisms) and the requirements being put to it (designated uses; ongoing and planned works). The results are presented in this section.

A qualitative and quantitative analysis of the data gathered through this assessment enabled the identification of factors influencing the comfort provision and environmental performance of heritage buildings in Malta. These factors include room use (Section 5.2.1), piecemeal works and frequent changes (Section 5.2.2), as well as building fabric, fittings and finishes (Section 5.2.3). The results, presented in this section, are also applicable in comparable countries with a similar climate and cultural context, particularly across the Mediterranean.

The architectonic assessment is in line with European guidelines on improving the energy performance of heritage buildings (EN16883: 2017). However, it was not limited to the building envelope and technical systems, but also considered the potential of passive environmental design strategies (hereafter referred to as PEDS) and traditional strategies to reduce energy demand.

5.2.1 Room Use Survey

In order to preserve heritage value, whilst also maximising occupant comfort, a building's potential and limitations should be clearly defined such that appropriate use/s may be selected within those parameters. SnAP was originally constructed as a residence, however, over the years, it has been adapted to incorporate a wider variety of elements, culminating in a highly mixed-use complex.

This is highlighted by the results of the room use survey, represented graphically on colour-coded plans[8] (Figure *5.2* and Figure *5.3*), and listed in Table *5.1*.

[8] The plans were produced by the Works and Infrastructure Department Project Design and Engineering Directorate at the request of Her Excellency, and adapted by the author in Figures 5.2 and 5.3.

Figure 5.2: Room Use Survey of Ground Floor at San Anton Palace

Figure 5.3: Room Use Survey of First Floor at San Anton Palace

Table 5.1: List of Uses, including the percentage of floor area dedicated to each use

Room Use	% of Total Rooms			Number of Rooms Both Levels
	Ground Floor	First Floor	Both Levels	
State Room	0	24	12	8
Office	15	8	11	16
Multi-purpose Room	4	5	5	6
Guest Room	0	8	4	7
Private Quarters	0	15	8	12
Services	11	1	6	8
Security	3	0	2	2
Workshop	14	1	7	14
Chapel	7	0	3	2
Storage	9	0	4	7
Toilet	3	0	2	2
Loggia	5	5	5	32
Passage	11	23	17	/
Loggia	18	10	14	10

The wide variety of uses incorporated in the palace adds to the complexity of the building. It increases the difficulty of providing occupant comfort and functionality by increasing the number of user groups, and associated requirements. This is further aggravated by the potential change in room uses at the discretion of an incoming president.

In undertaking the room use survey, it was discovered that several rooms were used for a dual purpose. For instance, state rooms may, at times, be used for meetings, seminars or receptions. When unoccupied, guest rooms were also used to host meetings. Where the use was noted to change frequently, the room was designated as 'multi-purpose'. Once again, this adds pressure to the building's potential to provide occupant comfort and functionality.

Excluding passageways (17%) and loggias (14%), at the time when the building survey was carried out, the greatest area was taken up by state rooms (12%) and office space (11%). The remaining uses were distributed rather evenly, with no particular use occupying more than 8% of the total floor area at both levels. Certain uses were designated to particular floors. For instance, state rooms, guest rooms and the private quarters were located at first floor only. This allows for rooms to be designed as dedicated spaces, where necessary incorporating the requirements of the secondary use.

Following this survey, office use was shifted completely to the ground floor. In order to accommodate this change, stores and industrial workshops at the ground floor were discontinued or moved out of the palace, allowing for the rooms to be restored and utilised more efficiently.

The strategy was intended to revert the first floor to a piano nobile[9]. This context emphasises the importance of carefully designing the offices, which have been relocated to rooms originally intended for a drastically different purpose. The shift exemplifies the nature of changes imposed on the palace in line with the requirements and strategy of an incoming president.

5.2.2 Survey of Works

As part of the architectonic assessment, a full survey of on-going and proposed modifications to SnAP provided a more in-depth understanding of the nature of changes to the palace. At the time when the survey was carried out, various works were being undertaken, or were scheduled for the foreseeable future. These works targeted:

- Restoration of particular rooms/areas;
- Interior re-design of particular rooms; and
- Changes to accommodate new uses and users.

5.2.3 Building Fabric, Fittings and Finishes Survey

The results of the room-specific review are presented and analysed in this section.

5.2.3.1 Building Fabric

Numerous examples of the PEDS discussed in Section 3.6 were identified through the architectonic assessment of the case study. These are typical of Maltese vernacular architecture, and many are also characteristic across the Mediterranean. The PEDS identified in SnAP include:

- Central courtyards (see Figure *5.4*);
- Loggias, generally south-facing (see Figure *5.4*);
- Well-positioned[10] windows and doors (both external and internal);
- Louvered apertures;
- Timber balcony, west-facing (see Figure *5.5*);
- High ceilings;
- Flat roofs having traditional structural configuration, referred to locally as deffun[11];
- Thick double-skinned external masonry walls with rubble-filled cavity;
- Use of building materials and finishes which promote natural cooling, such as flagstone flooring and light-coloured walls (see Figure *5.6*);
- Water cisterns;
- Externally-ventilated basements; and
- Surrounding indigenous trees and vegetation (see Figure *5.4*and Figure *5.5*).

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[9] Piano Nobile: the first floor level traditionally reserved for reception and private quarters.

[10] Well-positioned: The term *well-positioned* refers to apertures that are positioned in accordance with known passive design principles such as orientation and cross-ventilation.

[11] Deffun: a traditional waterproofing system for roofs comprising a mixture of ground terracotta, lime and globigerina limestone sand (Cini, 2006).

Figure 5.4: Central courtyard and south-facing loggia, San Anton Palace
(Source: A Wismayer)

Figure 5.5: West-facing timber balcony overlooking the private gardens, San Anton Palace
(Source: A Wismayer)

Figure 5.6: Traditional flagstone flooring and light-coloured walls, San Anton Palace (Source: A Wismayer)

It was found that, of these, interventions over the years had limited the potential of well-positioned windows and doors, louvered apertures, high ceilings, water cisterns, and building materials and finishes. Apertures are discussed in Section 5.2.3.2.

The building survey revealed that internal floor-to-ceiling heights had been lowered through the use of false ceilings. In many cases, these were used to conceal HVAC systems, such as air-conditioning units, whereas in other cases, the purpose was purely decorative. False ceilings conceal the building's structural configuration. This is of particular concern at first floor, where damage resulting from water leaks may not be immediately visible. Additionally, internal height has particular relevance when assessing natural ventilation (Li et al., 2013). In this context, airflow dynamics may be impacted when internal height is reduced. However, in certain rooms, such as offices and guest rooms, wherein active means of heating and cooling are more consistently used, a reduced internal height may facilitate heating/cooling.

Several water cisterns were found to have fallen into a state of disrepair. This is particularly significant given the extensive mature gardens surrounding the palace, that require irrigation. The restoration of these wells would enable significant water conservation and re-use.

The results of the building survey highlight that, in some instances, building materials and finishes had been replaced or amended as part of maintenance and interior design projects undertaken over the years. This is most evident in the floor finishing, which range from the original flagstones and marble slabs, to parquet and fitted carpeting (Figure *5.7*).

Figure 5.7: Floor finishes at San Anton Palace, ranging from original flagstone to parquet (Source: A Wismayer)

The results of the floor finish survey are presented in Table *5.2*.

Table 5.2: Floor finish as a percentage of the total floor area

Floor Level	**% of Total Floor Area**					
	Flagstones	**Marble**	**Tiles**	**Parquet**	**Fitted Carpets**	**Non-Slip Carpeting**
Ground Floor	60	15	18	0	0	7
First Floor	49	7	16	6	21	1
Total	55	10	17	3	11	4

In the main, the original flooring has been retained (flagstones and marble), particularly at ground floor level. However, new materials have also been introduced. Parquet flooring does not have the same potential in mitigating heat gains as flagstone and marble, and is generally not considered to be suitable for the Maltese climate. Additionally, fitted carpets are difficult to remove during the summer season, in line with traditional practice. At first floor, fitted carpets account for a significant percentage of total floor area (21%). Pertinently, these have generally been installed in guest rooms, potentially adding to thermal discomfort and the subsequent use of active control systems during warmer periods. In most cases, the new flooring has been laid over the original flagstones and may, therefore, be removed in future.

5.2.3.2 Apertures

Through the building survey, a total of 466 apertures were recorded: 48% internal, 46% external and 6% external onto a loggia. Of the total apertures, 98% comprise timber panel windows (Figure *5.8*) and doors with single glazing. Less than 2% of the external or loggia apertures have been fitted with double glazing. The findings, therefore, demonstrate that windows and doors at SnAP have been retained in their traditional form.

The following analysis focuses specifically on external and loggia apertures.

Windows are rated as the preferred method of environmental control (Barlow and Fiala, 2007). However, of the total external and loggia apertures at SnAP (N=244), the greater majority (71%) were found to be closed during the building survey. The survey was undertaken during office hours over the months of August and October 2015, when external air temperature ranged on average between 22$_o$C and 27$_o$C (Time and Date, 2015). It should be noted that almost half of the apertures providing access to, or overlooking, a loggia (48%) were found to be open. This highlights the significance of the loggia as a PEDS, and reinforces the importance of maximising its potential.

One of the reasons for the limited use of apertures as an environmental control mechanism may be that 56% of the total (N=244) were not fitted with an insect screen. Particularly in light of the location of SnAP surrounded by mature gardens, a lack of screens may cause disturbance to occupants, both those living and working at the palace, who consequently keep apertures closed. The sensitive installation of insect screens may encourage users to leave apertures open, relying on natural ventilation rather than artificial cooling (addressed in Section 5.2.3.4).

Figure 5.8: Timber apertures with louvres overlooking the private gardens, San Anton Palace (Source: A Wismayer)

Of the total number of windows (N=244), just under half (44%) are fitted with louvres, however the greater majority (70%) do not have curtains or sheers. Louvres enable greater environmental control, allowing for the room to be ventilated whilst shaded from direct sunlight or glare (see Figure *5.8*). This element is therefore considered to be a PEDS, and it characteristic of most heritage buildings in Malta.

Figure 5.9: Heavy, fixed curtains compromise the potential for environmental control, San Anton Palace (Source: A Wismayer)

The incorporation of curtains and sheers is also useful, and generally an aesthetic and functional requirement of the state rooms. Heavy, luxurious curtains are in line with the grandeur of these spaces, and protect the precious art and artefacts from sun damage (see Figure *5.9*). However, over 55% of the curtains and sheers are fixed, limiting environmental control. These are the result of interior design projects where the interest is almost purely aesthetic. Therefore, despite being valuable, they are not original to SnAP, and the fixed components are not in line with a design that maximises energy performance.

5.2.3.3 Lighting

A mix of three primary luminary types was identified through the building survey. These included incandescent bulbs (70%), compact fluorescent lamps (29%) and a negligible number of light-emitting diodes (1%), as presented in Table *5.3*.

Table 5.3: Bulb Categories Identified at San Anton Palace

Bulb Type	Total Number of Bulbs	Percentage of Total
Incandescent	945	70.42%
Compact Fluorescent Lamp (CFL)	392	29.21%
Light-emitting Diode (LED)	5	0.37%
Total	1342	100%

These figures represent the status of light bulbs at Snap towards the end of 2015, when the building survey was undertaken. An independent project was initiated to replace incandescent bulbs with more energy efficient bulbs. Therefore, the figures presented in Table *5.3* may have changed significantly.

5.2.3.4 Active Environmental Control

The following active mechanisms of environmental control were identified: air-conditioning units (n=56); ceiling-fixed and floor fans (n=37); fireplaces (n=16); electric heaters (n=8); a dehumidifier (n=1). During the HVAC survey, which was undertaken over a period of two months between September and October 2015, the status of the active environmental control system was recorded. It was found that 40% of the air-conditioner units were in use. This highlights a significant dependency on active cooling to provide occupant comfort. In contrast, of the identified ceiling-fixed and floor fans, less than 30% were in use.

In particular rooms, air-conditioning units were positioned such that their efficacy was compromised, e.g. placed behind the curtains in guest rooms. In other cases, their location did not provide holistic environmental control, creating hot/cold spots which cause discomfort to occupants, e.g. skewed over one particular desk in the offices. The positioning of HVACs is an integral consideration in layout design.

5.3 Occupant Survey

The occupant survey was used to evaluate users' behaviour and their perceptions of comfort and functionality at San Anton Palace. This provides a better understanding of the impact that occupants may have on energy demand in the case study and in other similar heritage buildings, as well as first-hand experience of the particular problems associated with adaptive reuse of this architectural typology.

5.3.1 Contextualising the Responses

The survey identified three main user profiles: permanent residents and guests; administrative staff; and service staff such as caterers, security personnel etc. Each category is represented in the cohort of respondents. At the time of the exercise, the staff and residents at San Anton Palace formed a sample set of 105. Approximately 33% (n=35) of the population set were interviewed. They provided feedback on a total of 31 rooms, comprising 39% administrative use (12 rooms), 26% residential (8 rooms), 19% state rooms (6 rooms) and 16% services (5 rooms). Percentages throughout this section are presented as round numbers.

Traditionally each new president selects the majority of his/her staff. Since a presidential term spans a five-year period, most administrative staff would not exceed that duration. This is reflected in the results, which show that participants' experience at the time of the interview was generally not more than 18 months, with only 20% of respondents having been at San Anton Palace for four years or more. In this context, it is particularly significant that the great majority of respondents (94%) were aware of recent or on-going modifications to the structure and/or layout of SnAP, indicating a high level of works. The following changes were recalled:

- Restoration of heritage fabric;
- Interior design interventions; and
- Changes in room use, predominately related to the reinstatement of state rooms at piano nobile, resulting in the conversion of rooms to office space on the ground floor.

It has been common practice for each president to undertake projects of this nature. Works are carried out depending on the area of interest of the new president, often requiring specific administrative support, as well as a personal choice of restoration/redecoration of state rooms within the palace. The results show that a holistic, long-term framework for a restoration and room-use strategy at SnAP is lacking.

The offices have a high number of occupants, and traffic. Due to a lack of meeting rooms and office space, management personnel move around the palace frequently, utilising several state rooms for meetings and events. As a result, several state rooms are multifunctional in nature, having primary and secondary uses.

5.3.2 Perceptions of Comfort and Functionality

The overall perception of comfort and functionality was negative. Satisfactory light and temperature conditions were the major cause for concern, moderated in part by occupants through a high dependency on active environmental control mechanisms.

Powdering of walls (Figure *5.10*) was also highlighted as an issue by participants. The phenomenon is common across heritage buildings in Malta where, in the climatic context, and as a result of moisture content in the porous limestone and the absence of a damp-proof course/membrane, the paint finish begins to powder or flack off the wall. If fair-faced, the masonry may also powder or flack. It is widely accepted amongst practicing professionals that the powdering or flacking of walls is aggravated by a lack of adequate cross-ventilation.

Figure 5.10: Powdering of limestone wall along the lower courses
(Source: A Wismayer)

The presence of powdering and flacking walls was recorded during the architectonic assessment. Spot Relative Humidity levels and moisture content were not recorded as part of this research. The results of the occupant survey demonstrated that respondents perceived humidity levels in San Anton Palace as being high, particularly at the ground floor. The perceived high humidity and lack of natural ventilation may be associated with the condition of the walls, particularly in rooms originally designed for other purposes or which were subsequently intervened upon.

Figure 5.11: State Room at San Anton Palace, sometimes used a meeting space
(Source: A Wismayer)

Building users generally felt awkward in the presence of valuable artefacts and furniture, particularly in dual-purpose rooms (Figure *5.11*). Despite this, a number of occupants expressed a willingness to compromise on comfort in appreciation of the palace's heritage value, and a wish to learn more about its history. The results are categorised and presented below in more detail.

5.3.2.1 Room Layout

The majority of respondents felt that room layout does not maximise comfort (74%). The remainder (26%), remarked that comfort was sufficient but not ideal, and more than half of this group noted that they are heavily dependent on artificial heating/cooling mechanisms (Figure *5.12*). Thermal discomfort was cited as a serious concern. The disparity of responses in this context clearly indicates that the positioning of HVAC systems results in some occupants feeling too hot, whilst others are too cold. This may lead to tension between users seeking to achieve better personal environmental control.

Consider an office space as an example: Participant A whose desk is directly below the air-conditioning unit generally feels uncomfortably cold, responding as such during the survey, whilst Participant B seated on the opposite end of the room, in an area that is frequently exposed to direct sunlight generally feels uncomfortably hot. Whereas Participant B requests that the air-conditioning is used often to cool the room, Participant A insists that it is switched off, thereby resulting in disputes on environment control.

Figure 5.12: Lighting system for a converted office space, San Anton Palace
(Source: A Wismayer)

Figure 5.13: Loggia utilised as a work space
(Source: A Wismayer)

Other major grievances include insufficient lighting and ventilation, humidity and flaking walls. These were mainly related to the furniture layout, particularly the placement of desks away from natural light and against the walls. Some occupants mitigated these issues by moving to the loggia whenever possible (Figure *5.13*). The use of a semi-outdoor space, such as the loggia, is in line with the principles of biophilic design, which promote the integration of natural elements and connections with nature in building design (Hayles and Aranda-Mena, 2018). Included amongst the benefits of this concept are improved well-being, diminished stress, enhanced productivity and greater satisfaction at the workplace (Gray and Birrell, 2014). SnAP lends itself towards exploiting these aspects.

The results also indicate that room layout does not generally meet the requirements of the specified use, with 64% of respondents agreeing that functionality is not maximised in this regard. This implies that the new use (e.g. offices) was assigned to the room (e.g. originally stores) without comprehensively retrofitting the space to meet the associated demands. This is not conducive to an environment that promotes reduced energy use, but rather one which increases dependency on active means.

Consider a store (original use) to be converted into an office space (new use), as an example: Given that the room was originally built to be utilised as a store, the design of the space may not provide adequate natural light and ventilation through the incorporation of sufficient well-positioned apertures. Prior to changing the use, an assessment on whether the room may be retrofitted to accommodate the associated office use demands (including adequate light and ventilation) should be undertaken. In addition, the room layout should also be studied in order to maximise occupant comfort.

Layout design has an impact on energy performance, as well as user comfort (Mohammadi et al, 2014), and should therefore be approached with consideration of the particularities of the heritage building.

5.3.2.2 Furnishings

Approximately one third of respondents were satisfied that the furnishings of the rooms they used were fit for purpose. However, of these, several participants held roles related to the services sector (e.g. kitchen and pantry). On the other hand, office and residential furnishings were not satisfactory to the majority of participants (69%), with poor lighting (both natural and artificial) and inadequate furniture being flagged, as well as insufficient desk space, privacy and storage.

The overwhelming majority of occupants (77%) move furnishings (desks, laptops and chairs) in order to improve functionality, however, they were apprehensive regarding the possibility of damaging items of value. Space restrictions prevented the remainder from moving furnishings, despite wishing to do so. Almost half of respondents (46%) preferred to move themselves, rather than the furnishings, in order to improve light, ventilation, thermal comfort and acoustic conditions. Both residents and administrative staff who had access to a loggia elected to utilise it as a workspace whenever possible. This was corroborated by on-site observation, confirming that the loggias were almost constantly made use of.

The fact that occupants feel the need to move furnishings or themselves in an effort to improve functionality and comfort is symptomatic of inadequately designed spaces. Additionally, the fear of damaging heritage value items is probably resultant from hosting meetings in rooms not primarily designated as office space, as corroborated by the building survey. This highlights the importance of designating dedicated administration areas, which are specifically designed for the purpose.

5.3.2.3 Environmental Control

Approximately 54% of participants open windows and doors for ventilation, and the remainder do not do so mainly due to factors beyond their control (pollution, impractical, privacy, security, no windows). Over half of both groups of participants resort to HVAC for cooling. This indicates that opening windows and doors is not sufficient to provide thermal comfort. However, the results also demonstrate that air-conditioning is being used inefficiently since it is often coupled with open windows. The high dependency on artificial cooling mechanisms is perhaps symptomatic of learnt behaviour

Occupants open or close louvres and curtains for comfort (77%) and functionality (83%) in order to reduce glare or improve lighting levels. However, they also reported cases of inaccessible or inoperable louvres, and curtains which are difficult or delicate to manage. This severely and needlessly restricts environmental control, and aggravates the already high dependency on artificial mechanisms.

Artificial light is used extensively. Since artificial lighting is responsible for a notable amount of total electricity consumption (Nagy et al., 2015), it is important to exploit the potential of natural lighting. However, this should be done carefully so as not to increase heat gains during summer. PEDS such as louvers and loggias maximise natural lighting whilst reducing heat gains. Occupants were frequently observed using the loggia, and making maximum use of rooms which enjoyed natural light, flagging a clear preference for working in these spaces when possible.

5.4 Semi-Structured Interview

The president’s perceptions and experiences of the palace were garnered through a semi-structured interview. The primary aim of this interview was to establish the perceptions of comfort and functionality at SnAP, as well as the scope of works undertaken during her tenure. The results are presented in Table *5.4*.

In contextualising her responses, it is pertinent to note that the president has past experience of heritage buildings, both as a residence and an office. She approached her term at SnAP with a deep appreciation of this architectural typology, and its historical and cultural value.

Table 5.4: Themes Emerging from the Semi-structured Interview with the President

Themes	Results
Perceptions of comfort and functionality at SnAP	Natural means of cooling and ventilation was preferred to air-conditioning, which is not used.
	Large louvered windows overlooking the private garden provide were considered to be an efficient means of environmental control, allowing for ample natural light and ventilation, as well as shading.
	It was noted that the porous local limestone (primary building material) results in a cold and humid environment.
	In general, SnAP was perceived as being very comfortable, affording modern requirements that meet the expectations of guests and occupants. It was felt that extreme weather may result in very hot or very cold interiors, however this was seen to have been aggravated by past interventions.
Scope of works undertaken at SnAP between March 2014 and March 2019	Restoration: Several restoration projects were undertaken, including the restoration and re-use of a two million litre water cistern.
	Provision of modern requirements: In line with approach towards SnAP as a working palace, the building was modernised to upgrade available technology and facilities. Security systems were upgraded. Additional air-conditioning units were installed to meet occupant expectations.
	Restructuring and Interior Design: Room designations were reorganised to shift offices to the ground floor and restore the piano nobile to its original use. For the ground floor to function as a business complex, workshops were relocated outside the palace, and stores were converted into a multipurpose conference. This involved the restoration and re-design of these spaces.
Impact of past interventions	Interior Design: The use of false ceilings was discouraged, allowing for the traditional ceiling structure to be appreciated, inspected and maintained. There was also concern that lowering the internal height may interfere with air dynamics and thermal comfort.
	PEDS: A system of air tunnels was discovered. The underground ventilation mechanism is original, incorporated to address humidity, and contributes to the good condition of stonework.
	Restoration: It was noted that, the condition of masonry had been visibly affected by humidity where apertures had been blocked or created, and where the building had been extended. Remedial measures supervised by the relevant authorities have been undertaken to stop damage.

The qualitative data derived was coded into three main themes.

- **Theme 1: Perceptions of Comfort and Functionality**

The findings of this interview reflect the residential use of SnAP, which was the original intended use of the building. In this context, the palace was perceived as performing well in providing both comfort and functionality. For example, large windows coupled with louvres were noted as maximising natural light and ventilation, and enabling environmental control, thereby greatly minimising the use of active mechanisms.

- **Themes 2 & 3: Scope of Works Undertaken & Impact of Past Interventions**

The results reinforce the hypothesis that heritage buildings, such as SnAP, were designed to provide comfort, and also highlight the impact of uninformed decision-making. Where interventions were carried out without an understanding of the mechanisms and physics pertaining to this particular architectural typology, environmental performance was negatively affected.

Works carried out during this presidency were undertaken sensitively, and under the supervision of relevant authorities, based on the ethos of the palace as a working building. In line with this principle, SnAP was upgraded where necessary to meet modern requirements, as the President explained during the interview:

"We had to modernise. Otherwise the palace would simply become a monument. This is a living building".

However, despite a personal preference for natural means of cooling and ventilation, upgrades included the installation of additional air-conditioning units to adhere to the expectations of other occupants and guests. This depicts the perception that a modern standard of living demands active means of environmental control.

As a primary occupant, the president played a central role in the projects undertaken at SnAP, taking an active interest in the interventions and contributing to the objectives. Her experience of heritage buildings was bolstered by the knowledge gained through this research, which she stated enabled informed decision-making.

5.5 Environmental Monitoring

Prior to enabling occupants' behavioural change, and developing eco-refurbishment proposals, it is critical to acquire and collate all relevant data in a scientifically robust manner: this may include indoor environmental assessment (Lovett et al., 2017). This is in line with European guidelines for improving energy performance of heritage buildings (EN16883: 2017), which specify that the measurement of such criteria should be carefully planned and cover a period of at least one year. Data loggers (Figure *5.14*) were installed in two distinct areas of SnAP, as illustrated in Figure 4.1 and 4.2, to monitor air temperature, humidity and carbon dioxide levels between November 2016 and March 2019, as described in Section 4.3.4.

Figure 5.14: Data loggers monitoring environmental parameters at San Anton Palace
(Source: A Wismayer)

As in any other research method, it is crucial to ensure that the data gathered is valid and robust. The environmental monitoring at SnAP revealed a number of user-related obstacles that were found to hinder the process, potentially impacting data integrity. The results are presented in Table *5.5*. Understanding these issues, before initiating a monitoring project will enable the researcher to take preventative action.

Table 5.5: Issues Encountered in the Monitoring Process

User-Related Issue	**Office Suite**	**Guest Rooms**
Occupant Interference		
Items placed on top of the equipment	X	
The position of the equipment was significantly altered	X	
Equipment was misplaced for a period of time	X	
Equipment was disconnected	X	X
Wire connection was removed and not returned		X
Logistical Interference		
Equipment disconnected for maintenance works	X	
Equipment disconnected for construction / demolition works	X	
Equipment disconnected for electrical works	X	
Physical division of one space into two separate rooms	X	

The results highlight that different user groups respond differently to the data sensors and monitoring process. Residents had a positive attitude towards the installation of monitoring equipment and adopted a sense of ownership. Conversely, employees required motivation: in particular, administrative staff generally exhibited a strong detachment to the data sensors. The value of the monitoring exercise was not appreciated enough to consciously support the presence of the equipment in the users' space. For example, the data sensors were frequently disconnected and moved to utilise the electrical outlet or space for other purposes.

There was no expectation that the environmental monitoring would be opposed by building users since it was supported by the President, a person of influence and authority. Actions were taken at different intervals over the course of the monitoring period to address the issues as they arose. These are listed below:

- The purpose of the monitoring equipment was explained;
- Information notices were placed near each set of data loggers. The notices outlined the purpose of the study, and provided instructions that the equipment is not to be switched off or disconnected;
- A dedicated space was identified for the equipment;
- Coordinators were appointed in each section. The coordinators were designated responsibility for the equipment and required to contact the researcher in the case of interference; and
- A memo was circulated to all staff outlining the purpose of the study. The staff was instructed not to interfere with the equipment, and to inform the coordinators immediately if the equipment was found to have been switched off or disconnected.

These actions mitigated interference to an extent in both the guest rooms and the office suite. However, since the coordinator in the office suite did not have a managerial role, works were scheduled without her knowledge and implemented in her absence. This implies that the coordinator should be a person in a high level of authority, or should be effectively supported by such a person.

Addressing these measures will contribute to the smoother management of the in-use environmental monitoring process. This is particularly pertinent when data loggers are installed in buildings that are concurrently hosting a varied mix of different occupant groups. The lessons learnt through the environmental monitoring exercise informed the recommendations presented in Section 7.2.7.

5.6 Concluding Remarks

This chapter presents the results of the case-specific study, gathered through an architectonic assessment, an occupant survey and environmental monitoring.

The results provide an understanding of the architectonic characteristics of San Anton Palace, Attard, offering detailed data on the mixed-use nature of the building, as well as its fabric, fittings and furnishings. The perspectives of the palace occupants and users, including Her Excellency, the President Emeritus, on comfort and functionality are also explored. Difficulties in monitoring the environmental parameters of the case study are outlined.

The next chapter focuses on the results of the wider study.

Chapter: 6 Results and Analysis of the Wider Study

6.1 Introduction

This chapter presents the results of a wider study, undertaken to address Research Aim 2:

To examine the different aspects of the sustainable regeneration of built heritage in Malta and whether these support the sensitive, adaptive re-use of historic architecture.

Both qualitative and quantitative data was derived using workshops, a focus group and a questionnaire, as described in Section 4.4. Table *6.1* provides a summary of how each research tool was applied in the wider study, including the associated population size of respondents.

- Of the total participants (N=66) who attended Event A, 59 participated in the workshops.
- Of the total participants (N=51) who attended Event B, 47 completed the questionnaire.
- Of the total participants who attended Event C (N=12) and Event D (N=3), all participated in the respective workshops and focus group.

Table 6.1: Research Tools, and Sample Sizes, used in the Wider Study

Action	Reference	Research Tool	Sample Size	Participants
Event A: Stakeholders Workshop 19th September 2016	Event A1	Workshop: Heritage Building Interiors	16	- Policy-makers, regulators, operators; - Professionals, including architects and engineers; - Academia; - Non-governmental organisations.
	Event A2	Workshop: Eco-Refurbishment of Heritage Buildings	19	
	Event A3	Workshop: Environmental Performance of Heritage Buildings	24	
Event B Public Seminar 4 April 2018	Event B	Questionnaire	47	Self-selecting sample of the public.
Event C Planning Authority Workshop 5 June 2018	Event C1	Workshop: Senior Management	6	Senior management of the Planning Authority.
	Event C2	Workshop: On-the-Ground Operators	6	On-the-ground operators representing various departments within the Planning Authority.
Event D Stakeholders Focus Group 30 July 2018	Event D	Focus Group	3	Representatives of the: Faculty for the Built Environment; Chamber of Architects and Civil Engineers; Building Regulations Office.

The results of the wider study are presented thematically in Sections 6.2-6.4. Three predominant themes emerged, namely:

- Public Awareness, Attitude and Behaviour (Section 6.2);
- Education, Skills and Competences (Section 6.3); and
- Policy and Procedures (Section 6.4).

The results highlight a need for improvement measures in all of these areas designed to support the sustainable regeneration of built heritage (SRBH) in Malta.

6.2 Public Awareness, Attitude and Behaviour

A strategy for improving public perception and awareness of the SRBH may only be developed once the current status has been benchmarked. This is in line with Objective 2A of this research:

To evaluate the public's perceptions of the sustainable regeneration of built heritage and heritage buildings in Malta, and the level of awareness regarding the applications of passive environmental design strategies.

An indication of actual perceptions, attitudes and awareness levels was gained by testing the respondents of the public questionnaire (Event B). The results are presented in Section 6.2.1. In addition, further insight was garnered from the perceptions of key stakeholders in the field formulated through their work experience (Events A, C-D), described in Sections 6.2.2-6.2.4.

6.2.1 Public Awareness and Attitudes: Results of Public Questionnaire

A questionnaire survey was used to obtain a preliminary indication of the public's perception of heritage buildings and understanding of inherent passive environmental design strategies (PEDS). This section describes the results of the public questionnaire. Whereas, due to the size of the sample, most of the results are not statistically inferable to the wider population, the findings provide insight through the perceptions of the group of respondents.

As described in Section 4.4.2., the questionnaire (Appendix C) was divided into two parts, and paired with a public seminar and study tour of San Anton Palace. Part A was completed before the seminar and Part B, which incorporates questions repeated from Part A, was completed afterwards. This was done to determine whether the information disseminated throughout the seminar would alter the respondents' views.

An analysis of the data, computed using SPSS (McNemar's Test with paired data), concluded that a statistically relevant change could not be inferred due to the sample size. However, difference in the responses pre- and post-seminar provide an indication of how dissemination of information, through short lectures and first-hand experience of the case study, influenced the participants' perceptions, understanding and awareness in this context.

6.2.1.1 Contextualising the Respondents

This section presents the results of the following questions:

- Question A1: Gender;
- Question A2: Age;
- Question A3: Education level;
- Question A4: Experience living / working in a heritage building;
- Questions A5 & B1: Preference for living in a heritage or contemporary building;
- Question A6: Opinion on the current state of conservation and regeneration of heritage buildings in Malta; and
- Question A7: List three main problems that are commonly associated with heritage buildings.

The self-selecting sample (N=47), comprising both male (40%) and female (60%) respondents, was representative of all age groups (15%: less than 25 years of age; 32%: between 25 and 44 years of age; 38%: between 45 and 64 years of age; and 15%: 65 years of age or more). The majority of respondents (81%) had a tertiary level of education, and the remainder (19%) had a secondary .

Just under half of the respondents (n=23) lived or worked in a heritage building. The results, therefore, illustrate both experiences and perceptions.

Questions A5 & B1: Preference for living in a heritage building or a contemporary building

The majority (n=29) registered a preference for living in a heritage building when responding the Question A5. There was a slight increase in preference for heritage buildings after the seminar: respondents who did not choose a preference before (n=2), selected heritage after.

The preference for heritage buildings was mainly associated with the charm, character or aesthetic, and historic value (see Figure *6.1*), that this architectural typology offers. For example:

> "*Heritage buildings are part of history, and living in them is like adding a layer to that.*"

Environmental performance was given little merit in comparison:

> *"The history, character and charm of heritage buildings outweighs lack of comfort."*

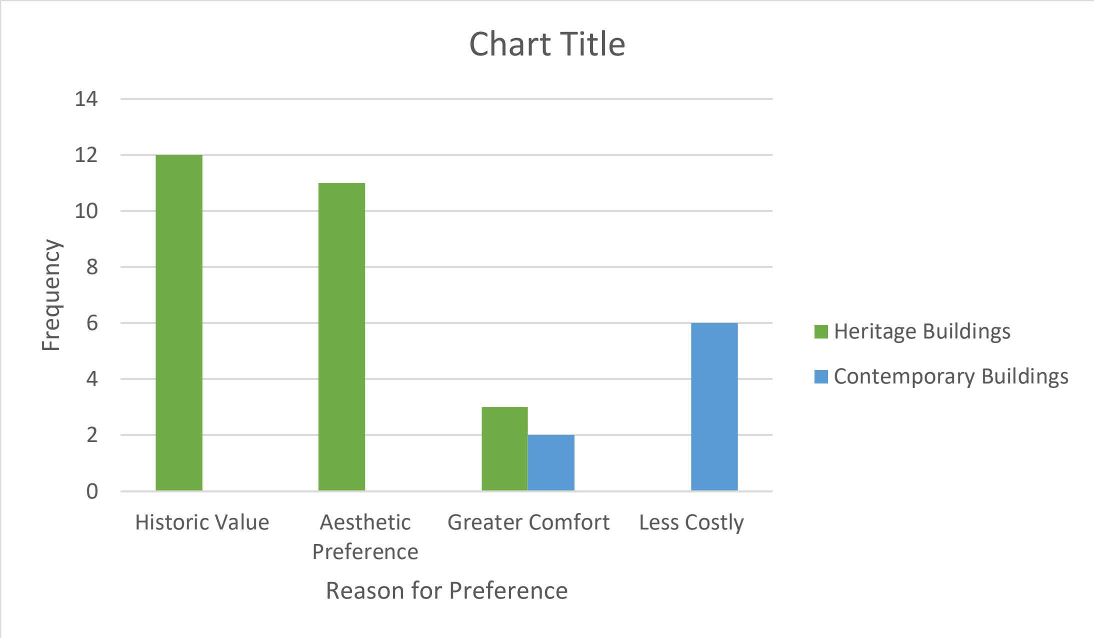

Figure 6.1: Reasons for preference of living in a heritage or contemporary building

The results of Question A5 also indicate that, although the majority of participants would prefer to live in a heritage building, the expense of purchasing, restoring and maintaining a heritage building was a deterrent:

> *"It was hard to find a heritage building for a reasonable price, if not a ruin itself."*

> *"I live in a contemporary building because a heritage building is so expensive to buy and maintain."*

Question A5 (Preference for living in a heritage building or a contemporary building) examined against Question A4 (Experience living / working in a heritage building)

A Pearson Chi-Square Test for two-way contingency tables was used to examine the association between two categorical variables, specifically the respondents' experience with heritage buildings and their preference for heritage or contemporary buildings. The hypotheses were designated as follows:

- Null hypothesis: experience is not related to the preference of heritage or contemporary buildings; and
- Alternative hypothesis: there is an association between experience and preference.

The Asymptotic Significance ($p < 0.05$) provided statistical evidence to support the alternative hypothesis, and reject the null hypothesis, indicating that:

- A preference for heritage buildings is associated with experience of this typology; and
- A preference for contemporary buildings is associated with no experience of heritage buildings.

Question A6: Opinion on the current state of conservation and regeneration of heritage buildings in Malta

When asked about the state of conservation and regeneration of heritage buildings in Malta, there was an overall acknowledgement of change for the better, although it was felt that more needs to be done in this area. Government incentives were noted positively, and linked to the improving situation and increased awareness.

On the other hand, the Planning Authority received substantial criticism. Examples of key comments are presented below:

"Planning Authority is allowing too much demolition and alterations."
"Misguided policies that do more harm than good."
"Too much demolition."
"More protection / scheduling needed."

Respondents also highlighted a need for education and training, for example:

"Unfortunately, periti[12] still lack basic knowledge."

Question A7: List three main problems that are commonly associated with heritage buildings

When the respondents were asked to list three main problems associated with heritage buildings, the need for more forceful action to ensure the SRBH in Malta was highlighted.

Figure *6.2* presents the themes which emerge from the results of this question.

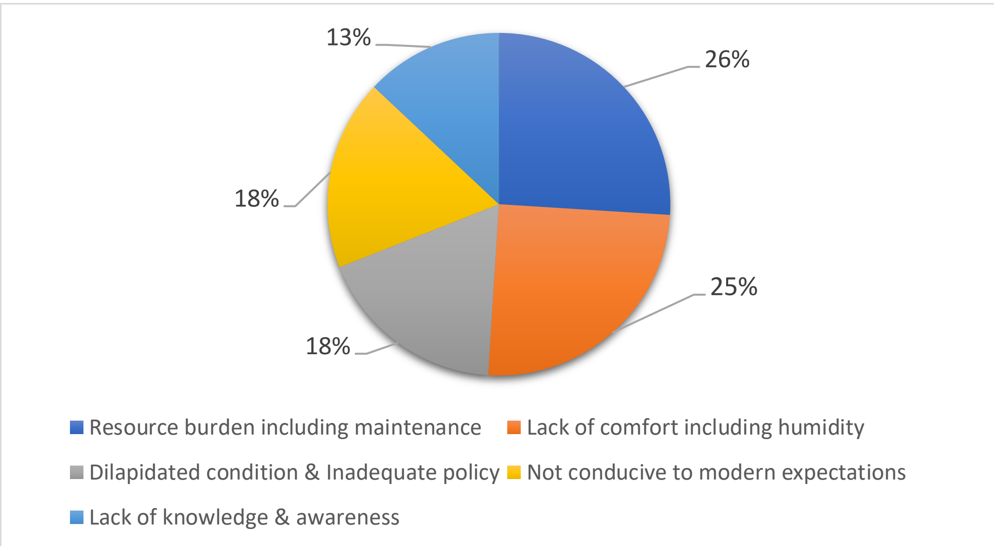

Figure 6.2: Main problems commonly associated with heritage buildings

[12] Perit: title of warranted architect and civil or structural engineer in Malta (Kamra tal-Periti, 2018b)

The findings highlight a perception that heritage buildings fall short of modern lifestyle expectations, and lack environmental comfort. The latter was listed as the most common problem, after a resource burden associated with time and cost implications. This may foster an environment where heritage buildings are perceived as more problematic than contemporary buildings, and are consequently not taken up as residences. The lack of knowledge and awareness, which was also noted, may exacerbate this situation.

This result is reiterated in Section 6.2.1.2, which addresses availability of information and guidance on heritage buildings, and the respondents' approach to an intervention project.

6.2.1.2 Respondents' Perceptions and Understanding of Heritage Buildings

This section presents the results of the following questions:

- Questions A8 and B2: Rank, in order of importance, the goals you would set when undertaking a heritage building project, numbering them from 1 to 7, 1 being the most important;
- Question A9: Rank in order of difficulty the main obstacles associated with undertaking a heritage building project, numbering the items from 1 to 9, 1 being the greatest obstacle;
- Question A10: Would any of the listed problems/obstacles discourage you from living in a heritage building?;
- Question A11: If you have been involved, as an owner or otherwise, in a heritage building project, do you feel that enough information and guidance was available?
- Questions A12 and B3: Do you think that energy demand is inherently greater in heritage buildings than it is in modern buildings?; and
- Question A17: In your opinion, is there enough information and guidance available for persons wishing to improve the energy efficiency of a heritage building?

Questions A8 and B2: Rank, in order of importance, the goals you would set when undertaking a heritage building project, numbering them from 1 to 7, 1 being the most important

Respondents were given a list of predefined goals in a heritage building project brief, and asked to rank these in order of importance both before and after the seminar (Questions A8 and B2). This allowed for an understanding of the respondents' priorities when undertaking a heritage building intervention project.

Figure *6.3* shows the goals that achieved the highest (ranked 1-3) and lowest (ranked 5-7) scores, pre- and post-seminar.

Figure 6.3: Goals in a heritage building project ranked highest (ranked 1-3) and lowest (ranked 5-7)

Except for "conserving heritage features", all goals in the top three ranking scored slightly higher after the seminar. Moreover, the goals ranked in the bottom three before the seminar were given a lower score afterwards. This indicates that the seminar had some influence on the respondents' views.

Question A9: Rank in order of difficulty the main obstacles associated with undertaking a heritage building project, numbering the items from 1 to 9, 1 being the greatest obstacle

Table *6.2* illustrates the order in which respondents ranked the predefined obstacles associated with undertaking a heritage building project. The first two criteria (humidity and the Planning Authority) received a high ranking significantly more frequently than the rest. Humidity is a major problem, and difficult to overcome in the rehabilitation of heritage buildings. The Planning Authority was perceived as the second major hindrance in dealing with this kind of project. This may be related to the policing attitude of the Authority, and the focus on preservation with little consideration of comfort provision or adapting the building to contemporary standards. These aspects will be discussed in further detail in Section 6.4.

Making the building beautiful was of lowest concern to the participants. This emphasises the respondents' appreciation for the inherent aesthetic present in built heritage, supporting the results presented in Section 6.2.1.1.

Table 6.2: Obstacles associated with a heritage building project that received a top three ranking

Ranking in 1-3	**Frequency**
Addressing humidity	40
Dealing with the Planning Authority	25
Ensuring modern standards of living	16
Ensuring sufficient natural light	15
Insulating external walls / roof	13
Ensuring sufficient natural ventilation	11
Addressing draughts	8
Making the building beautiful	6

Question A10: Would any of the listed problems/obstacles discourage you from living in a heritage building?

The respondents were also asked whether these problems would discourage them from living in a heritage building. The results indicate that any of these issues would be a deterrent, and highlight areas that form public perception. This implies that increasing the level of awareness is this area should be addressed in order to support the SRBH.

Question A11: If you have been involved, as an owner or otherwise, in a heritage building project, do you feel that enough information and guidance was available?

The majority of the respondents (64%) had been involved in a heritage building project. The larger proportion of this cohort (67%) felt that available information and guidance was insufficient. The areas where this was lacking focused predominantly on general knowledge regarding heritage buildings, as well as solutions and resources available to address the challenges of regeneration projects. Resources listed included materials, skilled workers and funding opportunities. Information regarding appropriate and effective maintenance procedures was also noted to be lacking.

Question A17: In your opinion, is there enough information and guidance available for persons wishing to improve the energy efficiency of a heritage building?

Participants did not consider energy efficiency when listing areas where information and guidance is lacking in response to Question A11. However, when asked directly (Question A17) the overwhelming majority (83%) of respondents felt that information and guidance on improving the energy efficiency of a heritage building in Malta is not available. This implies that energy efficiency is generally not correlated to heritage value.

Questions A12 and B3: Do you think that energy demand is inherently greater in heritage buildings than it is in modern buildings?

Prior to the seminar and study tour, 41% of respondents (n=19) believed energy demand to be greater in heritage buildings (see Figure *6.4*). Of the reasons given to justify a perception of greater energy demand in heritage buildings, the majority (69%) were based on the notion that these are inherently energy inefficient. Prominent examples of reasons given included:

"Large rooms and poor insulation"

"The buildings have not been planned to suit energy saving characteristics or requirements".

In contrast, over half of the reasons (56%) justifying why contemporary buildings consume more energy were founded on an understanding of the comfort provision of heritage architecture:

"Ventilation, insulation etc. were incorporated into the design [of heritage buildings]"

"Most of the time, vernacular buildings are cooler in summer and warmer in winter".

In some cases, this was clearly related to experience, such as:

"I live in an old farmhouse which was built in order to maximise natural lighting, with thick walls for insulation. So, we barely use light and have no air-conditioners".

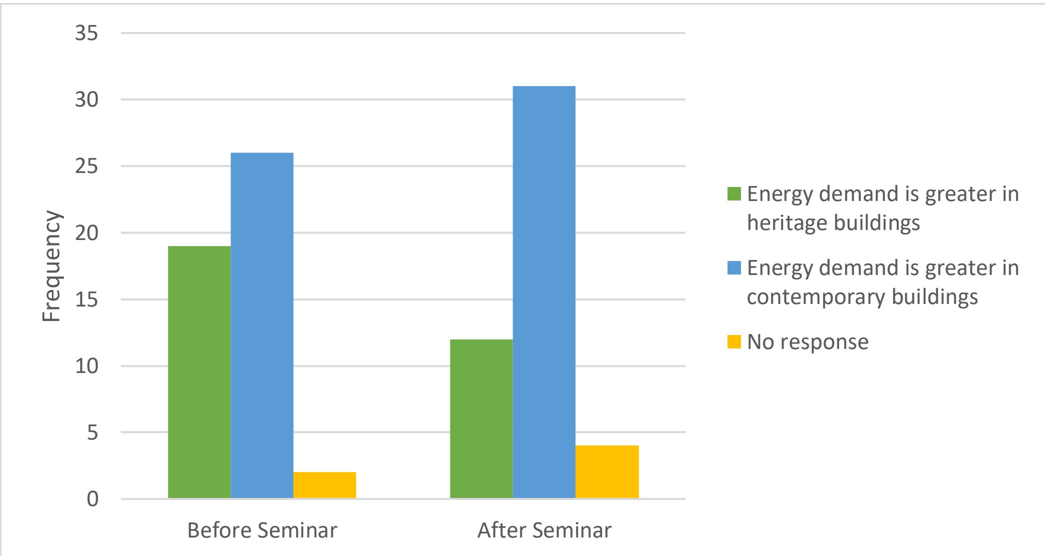

Figure 6.4: Energy demand as perceived before and after seminar

Figure *6.4* presents the results of the same question asked before and after the seminar (Questions A12 and B3). The findings indicate that the dissemination of information impacted the respondents' perceptions and understanding of the energy performance benefits of heritage buildings. This will be addressed in more detail in the following section.

6.2.1.3 Respondents' Awareness of Passive Environmental Design Strategies

This section presents the results of the following questions:

- Question A13: List two means of improving the energy efficiency of a modern building;
- Questions A14 and B4: List two means of improving the energy efficiency of a heritage building;
- Questions A15 and B5: Briefly describe the expected result of the following changes (see Appendix C); and
- Questions A16 and B6: In your opinion, which of the following affect energy efficiency of a heritage building? (see Appendix C)

Questions A13 and A14: List two means of improving the energy efficiency of a modern building (A13) and a heritage building (A14)

Respondents were asked to list means of improving energy efficiency in heritage and contemporary buildings. The respondents were coded into four categories, namely: renewable solutions; technical measures; passive techniques; and other. The main findings are summarised below:

- Renewable energy sources were proposed for both (17% for heritage and 20% for contemporary). These included photovoltaic solar panels and solar water heaters, as well as wind energy;
- Technical measures, such as double glazing, energy efficiency lighting and low energy appliances, were mainly associated with contemporary buildings (18% for heritage and 37% for contemporary); and
- Passive techniques were recognised as improvement measures for both architectural typologies. Respondents suggested reducing sun exposure and improving natural lighting, as well as the incorporation of green facades and roofs. Louvred windows and water re-use were correlated to heritage buildings.

Additionally, alternative high-level improvements were also recommended, such as:
- Protecting solar rights (contemporary buildings); and
- Updating environmental design policies (heritage buildings).

Questions A14 and B4: List two means of improving the energy efficiency of heritage buildings

Participants were asked the same question, for heritage buildings only, after the seminar (Questions B4). The results demonstrate that the recognition of the role of PEDS in heritage buildings rose by 25% following the seminar, with an associated reduction of renewable energy sources (decrease of 11%). This illustrates the lack of awareness reported by participants, highlighting the need for a strategy to increase access to information, and motivate greater awareness.

Questions A15 and B5: Briefly describe the expected result of the following changes (see Appendix C)

Respondents were asked to describe the result they would expect from a list of interventions in heritage buildings. The same question was asked before (Question A15) and after (Question B5) the seminar. Responses were divided into those related and unrelated to energy performance. The results are tabulated as percentages below (Table *6.3*).

Table 6.3: Percentage of responses un/related to energy performance for each predefined intervention

Intervention	**Responses related to energy performance**		**Responses unrelated to energy performance**		**Unanswered**	
	Pre-seminar	**Post-seminar**	**Pre-seminar**	**Post-seminar**	**Pre-seminar**	**Post-seminar**
Reducing wall thickness	55	72	11	4	34	24
Roofing the internal courtyard	62	81	4	0	34	19
Removing louvred shutters	49	74	2	2	49	24
Retaining a traditional roof structure, known as 'deffun'	19	51	13	13	68	36
Applying a white membrane over the roof:	53	60	4	0	43	40
Increasing the size/amount of glazed area	45	51	19	13	36	36
Using parquet as a flooring finish instead of traditional ceramic tiles	19	45	21	23	60	32

The findings highlight a lack of clarity on the impact of the intervention on the performance of PEDS. The respondents did not recognise PEDS as a tool for maximising environmental comfort. For example, both the reduction of wall thickness, and roofing of the internal courtyard, were associated with an increase in floor area, but not with an increase in energy demand. Similarly, removing louvres was associated with the loss of character, heritage value and privacy, rather than the loss of an environmental control mechanism. The lowest level of awareness was noted in the application of the traditional deffun[13] roofing system and cement tiles, where the pre- and post-seminar difference was greatest. The installation of parquet flooring, in particular, was correlated to an aesthetic outcome:

"Giving a more modern look, which does not go well with heritage buildings."

13 Deffun: a traditional waterproofing system for roofs constituting a mixture of ground terracotta, lime and globigerina limestone sand (Cini, 2006)

“Reduces the traditional characteristics.”

“Looks nicer.”

The results demonstrate that the correlation of PEDS to comfort and energy demand was generally better understood after the seminar, with a registered increase in responses relating the energy performance. This indicates that the dissemination of information had a positive effect on their level of awareness. In some cases, after the seminar, participants were also able to correlate two PEDS, or apply one PEDS to offset the negative impact of an intervention. For example, one participant proposed that a white membrane should be used on the deffun roof structure. In relation to increasing the size/amount of glazed area, another participant noted that the greater heat gain could be offset using louvers.

As in question A15, an improvement in response, pre- and post-seminar, was also shown when respondents were asked which of the following features affect the energy efficiency of a heritage building (Questions A16 and B7). The results are tabulated as percentages below (Table *6.4*).

Table 6.4: Percentage of correct/incorrect responses for each of the listed building features

Item	**Correct responses**		**Incorrect responses**		**Unanswered**	
	Pre-seminar	**Post-seminar**	**Pre-seminar**	**Post-seminar**	**Pre-seminar**	**Post-seminar**
Thick walls with insulated cavity	85	89	10.5	6.5	4.5	4.5
Internal courtyard	70	81	19	12.5	11	6.5
Loggia	62	83	23	8.5	15	8.5
Well located apertures	76.5	83	15	8.5	8.5	8.5
Louvered windows	76.5	85	15	6.5	8.5	8.5
Deffun roofing	51	81	32	8.5	17	10.5
Limited areas of glazing	64	74.5	21	15	15	10.5
Traditional cement tiles	42.5	55.5	40.5	23.5	17	21

The responses presented in Table *6.4* indicate that, even before the seminar, respondents were able to identify PEDS. However, when analysed collectively, the results of questions A12 (Section 6.2.1.2) and A15 (Section 6.2.1.3) imply that participants were unable to associate the application of PEDS to heritage buildings. This is exemplified by a perceived need for more insulation in this typology (Question A12), which contrasts with the acknowledgement of the energy efficiency benefits associated with thick walls, typical of heritage buildings (Question A16).

Once again, the greatest change in understanding occurred in relation to traditional deffun roofing and cement tiles. However, participants scored better for each passive feature after the seminar. This corroborates the results of the previous section regarding an improved level of respondents' understanding of the energy performance potential of heritage buildings.

6.2.1.4 General Remarks

Section 6.2.1 highlights that the seminar had some influence on the respondents' views, demonstrated by the variance in responses before and after, as previously described. It generated interest and increased awareness in the topic with participants requesting follow up information. Although not statistically significant to the wider population, the change indicates that targeted information may influence perceptions and increase the level of awareness.

The event triggered dissemination of information at a national level. Table *6.5* lists the outputs following the public seminar, demonstrating the impact of the research so far, as well as highlighting interest triggered in this subject as a result. Additional detail is provided in Section 7.4.4 and Appendices F-H.

This context motivates the design and implementation of a more structured future framework.

Table 6.5: Outputs of the Public Seminar relating to dissemination of information

Output	Station/Newspaper	Programme/Article	Date/Page
National news broadcast	Public Broadcasting Channel: TVM	Evening News	6 April 2018
National newspaper article	Times of Malta	Promoting green energy in heritage buildings	7 April 2018 p.6
National newspaper article	The Independent	Maximising the performance of heritage buildings	7 April 2018 p.3
Live programme on national television	Public Broadcasting Channel: TVM	TVAM filmed live	11 April 2018
National radio programme	Radju Malta	NA	11 April 2018

6.2.2 Public Awareness and Attitudes: Perceptions of Stakeholders

Table *6.6* summarises the key issues related to public awareness and attitudes identified by the participants of the stakeholder's workshops (Event A), the Planning Authority workshops (Event C) and the stakeholder's focus group (Event D).

Table 6.6: Key issues identified on public awareness and attitudes

Key Issues Identified	**Event A1**	**Event A2**	**Event A3**	**Event C1**	**Event C2**	**Event D**
Lack of general awareness and basic understanding	X	X		X	X	
Preference for modern development		X				
Heritage buildings are valued for their charm, character and atmosphere		X			X	
Buyers do not consider building performance					X	
Owners / Developers prioritise cost and time when intervening on heritage buildings	X	X				
Developers oppose the inclusion of further obligations, and the associated costs					X	
Occupants alter the property without following correct procedures		X				
Public generally opt for cheap and quick solutions in building design elements	X				X	
Clients do not request or accept means of addressing environmental concerns in design proposals for heritage buildings			X	X		X
Proposals impinge negatively on PEDS					X	
Heritage buildings are not perceived as providing sufficient comfort levels without active environmental control systems			X	X		X
Public associate energy efficiency with renewable energy sources			X			

Home-owners and developers were generally perceived by participants as preferring modern development, which is consequently in greater demand. Participants of the stakeholders' workshop noted that the small niche market for heritage buildings value this typology for its charm, character and atmosphere. This was corroborated by the results of the Planning Authority workshop, during which there was consensus that public appreciation for heritage buildings is associated with aesthetic, and is not associated with the benefits of inherent PEDS.

A low level of public awareness and knowledge was overwhelmingly emphasised by participants. This was corroborated by the perception that potential buyers of heritage buildings do not consider the environmental performance of a property, as they would with criteria such as footprint and level of finishes. Additionally, the public was perceived as not able to associate PEDS with the heritage typology, and mainly addressing energy efficiency through renewable sources, such as photovoltaic solar panels. This was supported by the results of the questionnaire, wherein respondents did not cite environmental performance as a justification for preference of heritage buildings (Question A4) or an area where information regarding the subject is lacking (Question A11).

There was consensus amongst participants that the public do not perceive heritage buildings as providing adequate comfort levels unless active control systems are integrated, and developers consequently feed into this demand. Case Example 6.1 presented by a participant during the focus group, illustrates how this is manifested in practice.

The Hotel Conversion Case
"We had this argument when my firm was working on [the conversion of a prominent large-scale 18th century building of great historical value into a hotel]. My clients would say, "how is it possible that my customers will come without air-conditioning?" and I would tell them, "Come in August and experience it for yourself. You don't need it!" The point is that the rules for old buildings are different… Eventually, they gave up for other reasons, but in the end, they didn't accept it. In fact, we had to put in the AC pipes in the floors, just in case. They felt that you couldn't sell it without air-conditioning."

Case Example 6.1: The Hotel Conversion Case

Through their work experience, participants of the stakeholders workshop and focus group noted that, developers and occupants often alter heritage buildings without following correct procedures and, as a result, do not intervene sensitively. Refurbishment solutions are often selected on the basis of cost and time efficiency, with a focus on maximising the property's appeal to the market, rather than its environmental performance. Periti in the focus group reported that in their experience, clients neither request nor accept the inclusion of environmental concerns in the brief for heritage building refurbishment. This is clearly demonstrated by Case Example 6.1, described above, and necessitates regulation in this field.

This attitude was corroborated by the participants of the Planning Authority workshop. In their experience, not only do interventions generally under-value PEDS, but rather, PEDS are often negatively affected. The Wall Thickness Case (Case Example *6.2*), presented by a participant of the operators session, provides a clear example of how the value of PEDS is not understood, and how interventions impinge on their benefits PEDS to adhere to a contemporary lifestyle.

The Wall Thickness Case
"[Reducing] wall thickness is a problem I face often. People don't appreciate that it's actually energy efficient. I'm talking about the public here - the everyday applicant. People don't appreciate the energy efficiency of having double wall thickness: that it will retain heat, and it will help you. People think "Oh, we have double thickness, great! We can shave off part of it and increase space… Sometimes I struggle with architects for days just to convince them to keep the walls. So please tell me, how can we convince the everyday people to conserve the actual Maltese fabric when all they want is open plan?"

Case Example 6.2: The Wall Thickness Case

This is supported by the results of the public questionnaire, which indicated that a reduction in wall thickness is associated with an increase in area (Section 6.2.1.3).

Developers were perceived as a strong lobby against the inclusion of further obligations, and associated costs. This extends to environmental performance requirements. In addition, the experience of participants demonstrates that the public generally opts for mechanical means to provide comfort without assessing other design options. The finding is supported by the results of the questionnaire (Section 6.2.1.2), where the provision of natural light and ventilation in heritage buildings was not ranked as a major obstacle, possibly due to the fact that respondents rely on artificial systems to provide comfort.

6.2.3 Occupant Comfort and Behaviour

Section 2.3 highlights the value of considering and understanding the impact of occupant comfort and behaviour. This section outlines the stakeholders' perceptions on occupant comfort and behaviour, as well as the relationship with building energy performance. The topic of user comfort was raised and deliberated during both workshops and the focus group. Emphasis was placed on the importance of taking this into account in the development and assessment of design proposals.

Through their work experience, participants perceived the public as prioritising comfort, generally within a culture of instant gratification having little regard for the cost to heritage conservation or energy demand. There was consensus on a current trend to incorporate quick and less energy efficient solutions to meet comfort requirements in heritage buildings. Participants agreed that the public often immediately resort to active control systems:

- Without assessing other solutions;
- Without considering the impact of the installation of system infrastructure on the building fabric; and
- In some cases, despite the adequate comfort levels provided by heritage buildings.

This was illustrated by the Hotel Conversion Case (Case Example 6.1).

In this context, there was agreement on a public attitude, that lacks value for heritage or energy consideration, and strongly prioritises comfort without the will to find sensitive solutions. This calls for a strong regulatory system that supports the design and assessment of appropriate and effective heritage building interventions.

A lack of concern by occupants for the impact of their behaviour on the energy performance of the building was highlighted as a critical factor by the participants of both workshops. This was associated with the notion that active environmental control systems are perceived as a modern necessity, rather than a luxury. In this context, the importance of influencing occupant behaviour in maximising PEDS was emphasised.

Participants of the stakeholders workshop identified occupant requirements associated with the new use of a heritage buildings as an integral consideration in the design of an intervention. The current approach was noted as lacking a thorough study of this aspect in the process of use selection and in the proposal development. This was corroborated by the participants of the Planning Authority workshop, who discussed specific cases where comfort provision was not taken into account at an early stage of the project, resulting in active environmental control systems being incorporated as an afterthought. The impact of ignoring occupant comfort and behaviour on both heritage value and environmental performance was considered unsustainable.

6.2.4 Tools for Change

The participants of both workshops highlighted two specific mechanisms to instigate increased awareness, and a change in attitude and behaviour. Dissemination of information was considered to be an important means of improving public awareness and knowledge base in the field of SRBH. Incentives, including penalties, were regarded as an integral tool for instigating a change in behaviour. Both components are detailed below.

6.2.4.1 Effective Dissemination of Information

The results of the stakeholders workshop highlight a need to facilitate a shift towards PEDS in heritage buildings, for example:

"We have to push society to think in more sustainable terms."

There was agreement that dissemination of information comprises an effective means of increasing public interest in, and awareness of, the SRBH.

Like the respondents of the pubic questionnaire, Planning Authority workshop participants called for easily-accessible information on heritage and energy conservation, aimed predominantly at delivering an understanding of the value of following correct procedures in interventions on heritage buildings. The lack of easily accessible information of this nature is not conducive of a supportive framework for the SRBH.

There was agreement that an awareness campaign should start by targeting the public, thereby facilitating a more positive reaction from clients when periti propose eco-refurbishment solutions. In particular, it was recommended that information should be disseminated through schools to bring about a grassroots change in mentality.

The following dissemination tools were endorsed by the stakeholders workshop participants, as mechanisms to increase public awareness and knowledge base:

- Short courses;
- Social media platforms; and
- Media spots, including radio programmes.

Despite acknowledging the media as an effective tool in this context, there was concern that the lack of awareness and knowledge on the subjects of heritage and eco-solutions also extends to several reporters. This highlights the need for a point of reference for journalists to consult with before delivering information.

6.2.4.2 Incentivising Change

The use of grants and tax incentives were discussed during both workshops, and noted as having experienced much success when previously implemented in the local context. In the past such schemes triggered interest independently in heritage conservation and energy performance. This is in line with the concerns of the public questionnaire respondents who highlighted resource burden as a deterrent to living in heritage buildings (Section 6.2.1.1). One such example, presented by a participant of the eco-refurbishment session of the stakeholders workshop, is described in Case Example 6.3 below.

The Case of the Maltese Timber Balcony
"The Planning Authority launched a grant scheme for the restoration of traditional timber balconies. The scope was to encourage conservation by helping with the cost of maintenance. There was so much interest that it was extended, and even recently re-opened."

Case Example 6.3: The Case of the Maltese Timber Balcony

Participants suggested implementing a similar strategy to stimulate awareness of the SRBH. Specifically, economic incentives were recommended to subsidise sensitive eco-refurbishment interventions in heritage buildings, with particular focus on those which maximise PEDS. Another suggestion comprised linking the Energy Performance Certificate to the tax rebates.

Financial incentives were considered to be the only tool available to instigate a change in developers' attitude towards SRBH. It was suggested that these include stricter enforcement and penalties. In the case of office staff, participants proposed pairing positive and negative incentives by obliging occupants to contribute to high energy consumption costs, as well as re-distributing savings.

A lack of monitoring, validation and feedback was highlighted as a critical failing of past schemes.

6.3 Education, Skills and Competences

The topic of education, skills and competences emerged as common theme during both workshops and the focus group. This stems from Objective 2B of this research:

To appraise the knowledge base, and level of awareness of stakeholders involved in designing and assessing interventions on heritage buildings.

The results coded into this theme, presented in Section 6.3, specifically target the knowledge base of key players in the field of SRBH, including: working professionals, such as periti, engineers and interior designers; policy regulators and operators, such as planning assessment offices; non-governmental organisations related to heritage and sustainability; and product suppliers and installers.

There was unanimous agreement amongst the participants of the workshops and focus group, that heritage buildings were designed to maximise environmental performance and are, therefore, inherently energy efficient. However, there was also consensus that the existing infrastructure does not support education, continuing professional development and training in this field. This was particularly emphasised by the participants of the senior management Planning Authority workshop, who ranked improved education as being more important than policy formulation.

Participants of the operators Planning Authority workshop endorsed the need for a better knowledge base across the building industry, from licensed stonemasons to periti. It was noted that this should be complemented by improved competency in applying learnt principles. The current lack of general understanding was emphasised as a challenging barrier to the SRBH.

In addressing this issue, it is important to distinguish between a lack of understanding of known principles and their application, which should be gained, and gaps in knowledge base, which should be filled. The former may be garnered through formal education, continued professional development and training, depending on the group being targeted (Sections 6.3.1-6.3.2). Sections 6.3.3 and 6.3.4 will focus on the knowledge gaps identified by stakeholders, and the tools to address them.

6.3.1 Formal Education and Continuing Professional Development

The lack of general understanding was highlighted as an urgent concern by the participants of both workshops and the focus group, who emphasised the importance of tackling this issue.

The focus group discussion highlighted a serious problem with the undergraduate course for architecture in this field which, despite repeated effort, has not been successfully overcome. Although the subjects of conservation and environmental design should theoretically intersect, the course was noted as being unsuccessful in instilling the meeting of these ideas at a conceptual stage. As a result, working graduates are unable to merge and apply these aspects in their design practice.

This was corroborated during the stakeholders workshop, with participants agreeing that the current approach to heritage building interventions does not incorporate building performance. It was also highlighted during the Planning Authority workshop as the experience of planning officers, who stated that PEDS are generally not considered or maximised in design proposals submitted by periti. Examples of this included a lack of attention to the design of windows based on orientation, and a reduction in wall thickness to increase internal area.

Deficiencies in formal education also extended to planners, as highlighted through the focus group. The diploma course for planners offered by the University of Malta was considered to be ineffectual and described as having been designed to cater to the level of education of the candidates, rather than targeting the level and depth of knowledge to be gained.

Participants of both workshops agreed that continuing professional development should be adopted as a means of improving the level of understanding. The stakeholders workshop specified subjects where knowledge base is lacking, and that should be tackled, including the assessment of anatomy and performance of heritage buildings. The Planning Authority workshop suggested tools for knowledge transfer, including seminars or workshops. The workshop also highlighted that although Chamber of Architects and Civil Engineers has the legal remit to consult with and advise government, so far, it has not made recommendations for continuing professional development.

Combined, formal education and continuing professional development should enable the professional to study the modern requirements of occupants, understand the building physics and develop the best design intervention within that context. This implies an integral need for an effective infrastructure to deliver education and continuing professional development to stakeholders of the SRBH.

6.3.2 Training

A lack of specialised training in the field of SRBH, was flagged as a concern by the participants of both workshops. Structured training courses were recommended for various groups with an interest in the field, to develop specific competences in defined areas. The results are illustrated in Table *6.7* below.

Table 6.7: Training requirements emerging from the Workshops (A & C) and Focus Group (D)

Group:	**Field of Training:**	**Scope of Training:**	**Emerging from:**
Periti	Assessing building energy performance and achieving minimum requirements in heritage buildings.	Enable periti to certify compliance with minimum energy performance, as obliged by law.	Event D
Energy Performance Assessors	Developing bespoke solutions for improving energy performance in heritage buildings on a case-by-case basis.	Enable assessors to customise the recommendations in the Energy Performance Certificate to the requirements of heritage buildings.	Event C
Interior Designers	Understanding the implications of design interventions on comfort and functionality, and environmental performance, in heritage buildings.	Enable interior designers to intervene sensitively and sustainably on heritage buildings.	Event A
Planning Officers	Assessing proposed interventions in heritage buildings.	Enable planning officers to shift towards assessment of bespoke solutions in heritage buildings.	Events A, C
Craftsmen, including carpenters and stonemasons.	Specialised in traditional materials and techniques, characteristic of local vernacular architecture.	Avoid loss of traditional skills.	Event C

6.3.3 Knowledge Gaps

Further to an investigation of the education, competence and skills of key players in the previous section, this section addresses gaps in knowledge base which, once identified, may be used to develop a systematic research strategy.

The lack of evidence-based data on the subject of environmental performance of heritage buildings was recognised by all stakeholders. It was agreed that more detailed information is necessary to guide retrofit decisions and enable good judgement. One participant noted that:

"With new buildings there are standards. With old buildings, we need research data."

There was agreement regarding the dependency on practical experience, and the need to shift from anecdotal information to high-level data. This need is corroborated by conflicting opinions that arose during the workshops. In one instance, for example, participants discussed the potential of water systems in heating/cooling measures for heritage buildings. However, there was divergence of opinion on the efficiency of this method in the local context, and anecdotal evidence was given both for and against the argument.

Knowledge gaps identified by the participants are outlined in Table *6.8*. These address: building fabric and environmental performance; occupant comfort; methods of intervention; costs and savings; and effective eco-refurbishment solutions.

This highlights the need to generate scientific data to address these gaps. Participants noted that this would be of great value to the industry, and recommended that it is fed back. The value of research was also emphasised in the context of having evidence-based data backing national environmental and heritage measures, such as government incentives for green technologies or restoration schemes.

On the subject of existing research, the focus group mainly referenced studies on contemporary buildings. There was agreement that minimal attention has been given to the environmental performance of heritage buildings in Malta, and that gaps of priority, such as those listed in Table *6.8*, are not being addressed. This implies that key players in the SRBH, including periti and policy-makers, are not supported in their role.

Table 6.8: Knowledge gaps emerging from the workshops (Stakeholders_A and Planning Authority_C), questionnaire (B) and the focus group (D)

Area of Research	**Knowledge Gap in Heritage Buildings**	**Emerging from:**
Building Fabric	Traditional technologies and the combined impact on environmental performance.	Event A1
	Traditional materials and the impact of incorporating contemporary materials	Events A1 and A2
	Maximising the benefits of passive environmental design strategies, such as the timber balcony, through innovative design solutions.	Event A2
Occupant Comfort	Comfort levels in heritage buildings and corresponding alignment with modern requirements	Event A2
	Addressing humidity problems in heritage buildings	Event B
	The efficacy of building management systems to provide comfort within the Mediterranean context.	Event A3
Methodologies for Intervention	Methods of assessing environmental performance and achieving minimum requirements.	Event D
	Sensitive intervention methods.	Event A2
	Sensitive incorporation of modern services	Event A1
Costs and Savings	Maintenance and associated costs.	Event A2
	Green benefits and associated savings.	Event A2
	Lifecycle savings achieved through investment in eco-refurbishment strategies.	Event C2
	Assessment of the value of grants, tax incentives and subsidies, through comparison of long-term returns against the national financial burden.	Event D
Case Studies	Repository of eco-solutions used successfully and unsuccessfully to address common issues.	Events A1 and A2
	Repository of effective and ineffective products and services	Event A2

6.3.4 Knowledge Sharing and Knowledge Transfer

The inability to transfer knowledge between stakeholder groups, mainly due to a lack thereof, was identified as a barrier to broadening understanding in this field. Where research has been carried out, the findings are not effectively disseminated back to the profession. In addition, there is little opportunity for professional-to-professional knowledge sharing, given the hesitance to claim responsibility for mistakes. Overcoming this obstacle was considered fundamental as knowledge sharing was seen to be key in addressing the lack of education.

The stakeholders workshop highlighted the value of knowledge transfer and knowledge sharing in documenting best practice cases of heritage building eco-refurbishment projects. In this regard, it was emphasised that both positive and negative examples should be documented. Online platforms, promoted through social media, were proposed as effective means of making these available to stakeholders.

Two examples of existing knowledge sharing and knowledge transfer mechanisms were identified. These are listed below respectively:

- Periti Discussion Group: a closed, members-only Facebook group for periti, established by the Maltese Chamber of Architects and Civil Engineers, currently used to submit questions to colleagues and exchange information. This was referenced as an ideal platform for knowledge sharing between professionals; and
- Ecobuild platform: a green building portal supported by the Building Industry Consultative Council, set-up to enable knowledge transfer regarding locally available products, services and technologies, as well as case studies of good practice. A BICC representative, participating in the stakeholders workshop, noted the dependency of this tool on people coming forward with case studies.

6.4 Policy and Procedure

The results presented in this section are in line with Objective 2C of this research:

To determine whether the existing regulatory framework targets and supports all relevant parameters in the design and assessment of heritage building interventions.

This section contextualises the existing infrastructure for the SRBH by outlining the stakeholders’ perspectives on generic policy (Section 6.4.1), as well as available detailed standards, technical guidance and best practices examples (Section 6.4.2). Roles and responsibilities emerging from this infrastructure are addressed (Section 6.4.3), and the design and assessment approach for interventions on heritage buildings is presented (Section 6.4.4).

6.4.1 Legislation and Policy

During the focus group, it was agreed that government entities have not shown leadership in this field, choosing to react rather than take affirmative measures, and that there is little acknowledgement of this situation and its implications. The experience of participants demonstrated that government does not always proactively transpose and implement European Union Directives, but rather takes action when faced with corresponding letters of formal notice. Stronger direction was highlighted as a critical factor in achieving industry-wide acceptance of the movement towards SRBH.

Participants noted that the approach towards improving energy efficiency has been motivated by Malta's obligations as a European Union member state, but has not been tailored to the local context. Examples of European-level obligations related to energy efficiency included:

- Provision of an Energy Performance Certificate; and
- Adherence to minimum energy performance requirements in buildings, according to Legal Notice 47/18.

During the focus group there was lack of clarity regarding the requirement to provide an Energy Performance Certificate for heritage buildings. Moreover, participants were uncertain whether heritage buildings are subject to the provisions of Legal Notice 47/18 requiring minimum energy performance standards. This highlights the uncertainty of periti regarding legislation in this area.

Having been driven by external pressures, initiatives to increase national interest and awareness on energy performance have neither focused on built heritage, and nor been founded on evidence-based data. This was clearly illustrated through a case presented during the focus group (Case Example 6.4).

The Case of the Photovoltaic Panels vs the Roof Garden
"When the government introduced the photovoltaic solar panel subsidy, there was no study which determined how much money Malta will actually save as a life cycle. It's not enough to say, now we'll be generating X% of our energy by renewable sources. So why did they do it? Because they were under pressure from Europe to collect the statistics, and the statistics for renewable energy sources were low. But if you had to look at the amount of money used in the subsidies, against the long-term returns, it's not the most efficient method. The University of Malta tried to get both political parties to endorse a subsidy for people to install a roof garden. We had shown the data - the insulation value increase, you improve stone water performance, you achieve an eco-system - they all told us yes, but nothing came of it because there's no pressure from Europe."

Case Example 6.4: The Case of the Photovoltaic Panels vs the Roof Garden

There was consensus on the need for a customised, comprehensive set of national building regulations based on scientific studies, and supported by targeted guidelines. This was considered to be particularly pertinent in light of recent revisions in local development control policy that shifted towards a contextual approach. This resulted in a generic document addressing all types of development, including heritage buildings in urban conservation areas.

Energy performance was perceived as a completely distinct component to heritage by both senior management and planning officers, and was clearly defined as an area that is not addressed through Planning Authority policy. Rather, energy efficiency concerns focus specifically on renewable sources, more specifically their location within the site, and are mainly associated with the Energy Performance Certificate. The Energy Performance Certificate was regarded as a bureaucratic necessity emanating from the European Union. It was perceived as an academic exercise with no actual value, designated to the Building Regulations Office.

Participants of the senior management Planning Authority workshop regarded policy as an inappropriate tool to impose specific direction regarding interventions on heritage buildings, and the impact of those interventions on environmental performance. Rather, the onus to justify a proposal was placed on the perit. In this regard, participants recommended increased education to support decision-making. This was emphasised in a context of a notable trend for designs which have little consideration for heritage value.

Through legislation, the onus for implementation and certification of minimum energy performance requirements, in accordance with technical guidance, has been placed on the perit. Although this was perceived by the focus group as a positive shift, because it gives more design control to the perit on energy issues, participants noted that:

- The profession is generally unaware of this responsibility and the related liability; and
- Ensuring adherence to the minimum requirements is difficult due to a restricted knowledge base and lack of guidance on the application of known principles to heritage buildings.

This context exemplifies the impact of inappropriate implementation of legalisation and policy on roles and responsibilities. Additionally, it highlights how this is further aggravated by a lack of standards, guidance and best practice, which will be addressed in following section.

6.4.2 Standards, Guidance and Best Practice

Case officers and senior management of the Planning Authority flagged a need for increased awareness and a change in attitude towards heritage, as well as improved cooperation from periti and the public. However, they identified enforcement as the tool to achieve this. Moreover, they experience difficulty in finding a best solution in assessing applications, and in outlining and enforcing permit conditions. The lack of standards, guidance and best practice on sustainable interventions in heritage buildings was identified as a critical issue by the participants of stakeholders workshop and the focus group.

The Craftsmanship Case
"We ran a project with Heritage Malta - it was a European funded project. At the end of the project we conducted training courses for carpenters for them to gain qualifications from levels 1 to 6, and it was quite successful. Our unit - the Heritage Planning Unit - has launched a number of restoration grant schemes. So [before] we visited a number of carpenters and learnt what the actual craft involved. Then we provided them with the level and standard of the work that the Planning Authority was expecting. I believe from that time onwards the quality of the work improved quite a lot, especially with timber balconies".

Case Example 6.5: The Craftsmanship Case

Participants called for standards and guidance relating to specific areas, e.g. the incorporation of contemporary materials in traditional buildings as part of a retrofit project. Setting standards for craftsmanship was shown to have improved the quality of work (Case Example 6.5). The case was presented during the operators session of the Planning Authority workshop.

There was agreement that existing guidance does not cater to vernacular architecture. The need for such guidance was emphasised in the context of the uniqueness of heritage buildings. Although this typology shares common features, each example is unique. Yet, there is no guidance on effective solutions to support informed decision-making in eco-refurbishment projects, and interventions on heritage building interiors. This highlights the need to develop targeted standards and guidelines, which is discussed in Section 7.3.4.3.

There was consensus on the need for best practice examples, accessible to planning officers (to support case-by-case assessment), the profession (to support the design process) and the public (to increase awareness and support a change in attitude). The provision of best practice examples was deemed crucial in developing an understanding of appropriate techniques for heritage building retrofits, as well as mistakes to avoid. It was also highlighted as a means of supporting behavioural change. However, planning officers referred to the permit conditions and the need for education when questioned about the availability of best practice examples.

6.4.3 Roles and Responsibilities

The participants of the focus groups noted concern on the subject of roles and responsibilities, which are currently not clearly defined. This was highlighted in the context of government inaction to drive the SRBH, as described in Section 6.4.1, and in lack of clarity across the profession regarding the role and associated responsibility of certifying compliance with minimum energy performance requirements. The focus group's uncertainly regarding the applicability of energy requirements to heritage buildings exemplifies this context.

The focus group participants endorsed the Building Regulations Office as the appropriate entity to retain responsibility for energy performance in buildings regulations, including heritage buildings. There was consensus that the Superintendence of Cultural Heritage should retain responsibility for built heritage. Additionally, it was agreed that the Planning Authority should reduce its remit to focus solely on planning issues. Insufficient resources were flagged as a critical factor in enabling the former two entities to effectively fulfil their roles, as corroborated during the Planning Authority workshop.

The above outlines the need for a robust framework of clearly defined roles and responsibilities, that enables and supports inter-disciplinary design and assessment of heritage building interventions.

6.4.4 Benchmarking the Current Approach

This section contextualises the obstacles in planning policy and procedure, as perceived by the stakeholders. It outlines shortfalls in the system as well as the measures they suggested to address them. Lastly, it highlights the main changes that participants proposed going forward.

Shortfalls of existing policy and procedure are listed in Table *6.9*. These were identified by the participants of both workshops and the focus group, as perceptions emerging from their experience in the field. Each was considered in developing the research recommendations.

Table 6.9: Shortfalls in the existing policy and procedure

Area:	**Shortfall and Measure:**	**Event:**
Policy & Procedure	Existing infrastructure is fragmented. Need for coordinated effort and common direction.	Event C1
	Lack of proper building regulations in Malta. Need for a designated authority responsible for implementation and enforcement of the regulations.	Events A1 and C2
	In some cases, existing policy and the lack thereof combine to discourage improving a building's energy performance. No changes suggested.	Event C1
	Assessment does not differentiate between new builds, and retrofitting of heritage and non-heritage buildings. No changes suggested.	Event C1
	The results of grants and subsidies are not filtered back to the Planning Authority. Need for monitoring and feedback loop.	Event C1
Roles & Responsibilities	The Planning Authority do not focus solely on planning. Need to reduce the Planning Authority's remit to planning.	Event D
	The legal remit to address energy performance currently lies with the Building Regulations Office. Willingness by the Planning Authority to adopt this role.	Event C1
	No entity to assess the inclusion of energy measures. No changes suggested.	Event C2
Proposal Design and Assessment	Energy efficiency and environmental performance are not considered in the assessment of development applications. No changes suggested.	Event C1
	The provision of the Energy Performance Certificate is unnecessary at development application stage. Submit following completion of works.	Event D
	The approach towards restoration is an extremely rigid and does not support eco-refurbishment of heritage buildings. Need for compromise.	Event A3
	Periti generally do not, but should, value and maximise passive environmental design strategies in their proposals. Need to educate periti.	Events C1 and C2
	Heritage building interventions are mostly dictated by budget. Need for compromise to enable restoration and re-use.	Event C1

The rate of applications received by the Planning Authority was noted as having increased considerably, and is continuing to do so. Table *6.10* lists the most common proposed interventions on heritage buildings, as listed by the participants of the Planning Authority workshop.

Table 6.10: Common Intervention proposals for heritage buildings

Proposed Intervention	**Notes**
Demolish and reconstruct	Comprises approximately 50% of applications received.
Reduce wall thickness	To gain space.
Enlarge apertures and doorways	Usually necessary in commercial development.
Roof courtyard	Or roof part of courtyard.

The requested proposals, listed in Table *6.10*, are generally correlated to the requirements generated by the new use of heritage building. Planning officers stated that, in the main, they do try to discourage interventions which impinge on heritage value, and consequently on PEDS. However, they were conscious that intervention on built fabric, to satisfy the requirements of a new use, is preferable to deterioration.

In order to safeguard heritage value, the Planning Authority resorts to the following mechanisms in the assessment and approval of applications:

- A Restoration Method Statement is requested and approved as one of the permit conditions;
- The Superintendence of Cultural Heritage is involved in both the assessment process for each application, as well as in enforcement as necessary; and
- The applicant may be obliged to engage a specialist to monitor the works since this expertise is not currently avails within the Planning Authority.

There is no mechanism to assess environmental performance. In response to queries regarding energy efficiency of heritage buildings, both senior management and planning officers referenced the Energy Performance Certificate, highlighting that this is not included in the remit of the Planning Authority. Additionally, whilst PEDS were recognised by the participants of the Planning Authority workshop, only cursory reference was made to their energy value; rather the conservation aspect was emphasised.

This is illustrated by the Planning Authority's response to the Courtyard Case (Case Example 4.1) which was presented to participants during the workshop, as explained in Section 4.4.4.

The Courtyard Case
"Consider a typical vernacular courtyard house, that has been abandoned and disused. The property is purchased by a young couple, who want to the convert the house into a residence. Since the stairs to the first floor are located externally in the courtyard, as is characteristic of this building typology, the conversion proposal submitted to the Planning Authority includes the structural removal a few stone slabs from one of the ceilings to create an internalised access to the first floor."

Case Example 4.1.: The Courtyard Case

The predominant response was to encourage the enclosure of the courtyard, or part thereof, with glazing, as an alternative to structurally intervening on the building fabric. Of the total responses received (N=12), half made this suggestion (n=6), whereas 25% (n=3) felt that the adjudication of the case should depend on heritage value. The proposal of removing stone slabs was immediately considered acceptable by 25% (n=3), based one/both of the following:

- An understanding of the impact of roofing the courtyard on heritage value and/or environmental performance of the building; and
- A preference for adaptive re-use over disuse, which is only possible if modern standards are attained through interventions to the building fabric.

The participants of the focus group were presented with the same case. There was consensus that the acceptability of the removal of the stone slabs was dependent on the uniqueness of the building. In the case of a high value building, the focus group agreed with limiting intervention as much as possible. In contrast, if the case dealt with one of several examples of any given type of heritage building, then habitability and comfort should be prioritised, with an ensuing change in value sequence. The focus group deemed the implications of either intervention (roofing the courtyard / removing the stone slabs) to be unrelated to planning, highlighting that it is inappropriate for the Planning Authority to be involved in adjudicating the case, particularly since planners are not trained to make such decisions. This highlights the need for case-based assessment through a redefined infrastructure that supports interdisciplinary collaboration.

The stakeholders workshop corroborated a rigid approach towards restoration which does not support the eco-refurbishment of heritage buildings. Shortfalls of the existing procedure for assessment were highlighted through an example presented by senior management in the Planning Authority workshop, and described below (Case Example *6.6*).

The Innovative Design Case
"At the last Malta Architects Awards that we had, a perit whose project was recommended for refusal multiple times ended up winning one of the awards. If I remember correctly, it was for adaptive re-use of heritage buildings. So that is why I would not say that we are always right or always wrong."

Case Example 6.6: The Innovative Design Case

Through a follow-up with the perit responsible for the project, it was discovered that the proposal was recommended for refusal by the planning officer several times. The recommendation was based on the fact that the contemporary design presented an aesthetic and materials that were not deemed acceptable in an urban conservation area. The proposal was finally accepted by the Planning Commission, following rigorous justification by the perit, and the development went on to win the Rehabilitation and Conservation Award at the Malta Architects Awards in 2017, sponsored by the Planning Authority itself. This implies that the policy used to adjudicate this case is not supportive of the SRBH.

A case-by-case approach to assessment was endorsed by participants of both workshops and the focus group. However, there was disagreement on detail as shown in Table *6.11* below.

Table 6.11: Changes to policy and procedure for heritage buildings, as deemed necessary by participants of the stakeholders workshop (A), Planning Authority workshop (C) & focus group (D)

Area:	**Changes going forward:**
Policy & Procedure	A blanket approach to policy does not allow for the context and particularities of each case to be considered. (Event A)
	There should be a shift to performance-based regulations. (Event A)
	Sustainable reuse of heritage buildings should be one of the ultimate goals in formulating policy and guidance. (Event A)
	Policy and guidance should support retrofitting strategies. (Event A)
	There should be willingness to sacrifice heritage value in order to ensure reuse by providing for occupant comfort. (Event C)
Proposal Design and Assessment	Energy efficiency need not always be a priority in the regeneration of built heritage. (Event A)
	The heritage value of the building may override the need for environmental performance considerations. (Event D)
	The nature of the use of the building may negate the need for environmental performance considerations. (Event D)
	Adaptive reuse is a very important aspect, and should be balanced with conservation to allow for occupant comfort. (Event A)
	Sustainable reuse should direct the design approach to developing a heritage building intervention. (Event A)
	Retrofitting strategies should be considered prior to works. (Event A)

6.5 Concluding Remarks

This chapter outlines the results of the wider study and identifies three key areas of priority in the sustainable regeneration of built heritage:

- Public Awareness, Attitude and Behaviour (Section 6.2);
- Education, Skills and Competences (Section 6.3); and
- Policy and Procedures (Section 6.4).

The perspectives of respondents and stakeholders are presented in order to develop an understanding of the benefits and shortfalls of the existing supportive infrastructure for key areas.

The findings of both the wider study and the case-specific study are discussed in Chapter Seven. The discussion incorporated the context of existing literature and highlights gaps in the knowledge base addressed through this research. Recommendations to address the issues raised are proposed. The limitations of the study are outlined, and areas requiring further investigation and/or validation are presented.

Chapter: 7 Discussion and Recommendations

7.1 Introduction

The results of both the case-specific study (Chapter: 5) and the wider study (Chapter: 6) are discussed in this chapter (Sections 7.2 and 7.3 respectively). Recommendations are proposed based on this discussion (Section 7.4). The limitations of this research are outlined (Section 7.5) and a case is made for future work building on this research (Section 7.6).

7.2 Case-Specific Study

7.2.1 Overview

There is recognition of the importance of occupants in improving the energy performance of heritage buildings (Ben and Steemers, 2014). Although research has addressed technological solutions in heritage buildings (e.g. 3ENCULT, 2014), studies which incorporate occupant behaviour have mainly focused on contemporary architecture (Fouseki and Cassar, 2014). The case study of San Anton Palace (SnAP) seeks to addresses this gap by evaluating aspects that influence occupant comfort and behaviour in a heritage building.

In line with **Research Aim 1** (Section 1.3), the study sought to determine whether the inherent environmental performance potential of SnAP is being maximised to provide occupant comfort and functionality, and enable environmentally conscious behaviour. The results demonstrate that the building's potential is not being fulfilled, particularly in the context of passive environmental design strategies (PEDS). Measures which may be taken to address this can be categorised into quick wins and long-term solutions. Whereas the former do not impact the building's historic value and may be implemented immediately and relatively easily, long-term solutions require strategic planning and, in some cases, research and innovative design.

This section discusses the finding of the case-specific study in the context of existing literature. It also proposes both immediate solutions and long-term measures in this regard and presents a procedural approach to the eco-refurbishment of large-scale, mixed use heritage buildings, developed through this research.

7.2.2 Designated Room Use Plan and Restoration Strategy

When this research was initiated, room use designation was haphazard and not necessarily conducive to providing occupant comfort and functionality. However, as the research progressed an independent project of works was initiated, as described in Section 5.2.1. and 5.2.2. The rationale of the project was to dedicate the first floor of SnAP to residential use and state rooms, whilst transferring operations to the ground floor.

The use designation of the first floor is in line with the intended purpose of the piano nobile: a floor dedicated to the formal reception of guests and private quarters. However, the ground floor was originally intended for services (e.g. workshops and stables) and must now also accommodate administrative and business use (e.g. offices and multipurpose conference hall). Providing comfort and functionality for this new use, within a context of energy efficiency, whilst remaining in line with the principles of sensitive heritage conservation, demands a long-term strategy.

European guidelines for improving the energy performance of historic buildings (EN16883: 2017) emphasise the critical importance of developing a future use strategy in order to ensure that the building can adequately meet the associated requirements without compromising heritage value. However, in the absence of a long-term strategy, the use configuration and restoration of SnAP is dependent on the objectives of each presidential term.

The results of the room use survey (Section 5.2.1.), and the occupant survey (Sections 5.3.1. and 5.3.2.) highlight the need for a such a strategy. There should be commitment to the allocation of designated uses to specific rooms, such that these spaces may be carefully designed to balance the three parameters (comfort and functionality, energy performance and heritage conservation) when meeting the requirements of the dedicated use. A room-use designation plan, developed by a cross-disciplinary team, should be complemented by a long-term restoration strategy. This should prioritise key areas with the scope of ensuring heritage preservation (e.g. possible damage to the structure) and maximising energy performance by conserving and utilising PEDS (e.g. restoration and reuse of water cisterns).

7.2.3 Occupants and PEDS

The findings of this study demonstrate that occupants unconsciously resort to the use of PEDS to ameliorate comfort conditions. For example, both the building and occupant survey (Section 5.3.2.1-5.3.2.3.) confirmed that loggias were often utilised as a preferred workspace. Although occupants did not rationalise their use of the loggia as a PEDS, in effect, it was popular because it provided users with optimal ventilation, shading and lighting.

Loggias, courtyards and balconies are examples of PEDS which embrace the concept of biophilic design to varying degrees, giving additional reason why they should be preserved and used. The literature indicates that connections to nature have the potential to induce behavioural change towards a more caring attitude to the environment (Ozer, 2014). This means of strengthening sustainable behaviour encourages the preservation and use of PEDS in heritage buildings.

The building survey identified several PEDS in SnAP. However, some were found to be under-utilised. Despite the express wish of occupants to open/close apertures for environmental control, it is not easy, practical or possible to do so in a number of cases. The reasons for this include accessibility, security or privacy, and the juxtaposition of conflicting uses. A variety of solutions exist to address these factors, e.g. the installation of insect screens, maintenance and retrofitting of the aperture, and easily adjustable curtains. These have the potential to improve comfort and functionality for occupants, and promote environmentally conscious behaviour. Additionally, research and innovative design should be used to study PEDS and maximise their potential, e.g. retrofitting timber louvres to allow for greater environmental control (3ENCULT, 2014).

7.2.4 Room Layout

The effective use of apertures and other PEDS is linked to a design layout that consciously seeks to utilise their potential. Layout design is directly associated to user comfort

(Mohammed, 2014). For instance, it has been shown that available natural light can be reduced significantly (by 11% on average) as a result of the furniture layout (Mousavis, 2018).

The findings demonstrate that room layout at SnAP is not optimal, e.g. desks located away from windows and against humid walls, creating discomfort and reducing natural light. This was aggravated by a lighting design that was not in tandem with the positioning of workspaces. Similarly, the location of HVAC systems reduced their efficacy, e.g. by being positioned either behind curtains or directly above a workspace. This leads to energy waste and does not provide an equalised thermal environment across the room. The room-use designation plan, described in Section 7.1.2., would enable the development and implementation of long-term, bespoke design solutions to meet the specific requirements of particular rooms.

An effective evaluation of occupant behaviour takes into account design layout and furnishings, since these influence users' interactions with the building, thereby impacting on energy demand (Delzendehe and Wu, 2017). This study revealed a high dependency on artificial environmental control mechanisms at SnAP. The results of the surveys (Sections 5.2.3.2., 5.2.3.4. and 5.3.2.3.) enable a redesign of some of the interior spaces with the aim of ameliorating comfort and functionality, and concurrently reducing energy consumption.

7.2.5 Evolving the Architectonic Survey

The results of the architectonic survey benchmark the status of SnAP (Section 5.2.) and enable informed decision-making on measures to be undertaken. These include maintenance, repair or solutions related to improving comfort, functionality, energy performance and heritage conservation.

The survey should be updated to reflect the changes being made. This would provide the basis of specific objectives to be monitored, for example: the transition from incandescent lamps to energy efficient bulbs; the installation of insect screens; and the repair of faulty apertures.

7.2.6 Assessment of Past Interventions and Lost Traditions

The findings reported in Sections 5.2.3.1. and 5.2.3.2. highlight past interventions on the building finishes and furnishings, which depart from the original architectural design and impact negatively on energy performance. In many instances, the reversal of these interventions may achieve the dual-objective of sensitive heritage conservation as well as eco-refurbishment, e.g. the removal of new flooring, such as parquet or fitted carpets, to uncover the original flagstones. The literature encourages the rediscovery of traditional household practices which enhance environmental performance (Berg et al., 2017). At SnAP, the use of removable (rather than fitted) carpets would be in line with such techniques, allowing for natural cooling through the flagstone flooring in summer. Additionally, the use of louvres and cross-ventilation should be complemented by seasonal curtains.

Literature recognises that changes which impact negatively on the inherent building physics and performance generally result in damage to the building fabric and integrity (Berg et al., 2017). This is supported by the findings of the semi-structured interview (Section 5.4.), which identify examples of such interventions, as well as their repercussions, e.g. the blocking or opening up of apertures and the resultant impact on ventilation and humidity. Whereas the reversal of some interventions may be relatively simple (e.g., removal of false ceilings), other solutions may require more intensive intervention (e.g., addressing the erosion of stonework).

7.2.7 In-Use Building Environmental Monitoring

Environmental monitoring is an important tool in performance assessment, and has been used extensively in research on heritage buildings (Section 2.5.2). Modern technology has facilitated the use of this methodology through the availability of low-cost data loggers, for which there is demand on the market (Lovett et al., 2017). However, environmental monitoring of in-use buildings presents a number of challenges (Guerra-Santin and Tweed, 2015), particularly when the building hosts a variety of occupant groups, as is the case in SnAP. Despite acknowledging the importance of engaging users in improving energy conscious behaviour (Pasini et al., 2017), there has been little guidance on a user-centred approach to environmental monitoring of in-use buildings.

This research highlights the importance of recognising and engaging the different user groups of the case study building, and addressing their respective outlooks in the monitoring process. Pasini et al. (2017) argue that occupants generally experience sensors in a passive way and, consequently, do not maintain a positive attitude towards the process for long periods typically required for monitoring. This may result in active disruption to the data sensors, as was demonstrated in the SnAP case study. To motivate and sustain a positive approach, user engagement should go beyond increasing awareness, and include customised goals and tangible benefits, particularly when users are not associated with energy costs, as in the case of the administrative staff at SnAP.

The user-related obstacles identified during the monitoring process, presented in Section 5.5, were addressed through remedial measures. The recommendations developed through this research should be considered as part of the methodology design before initiating similar monitoring projects, as preventative, user-centred action. These are listed below as best practice guidelines.

- **Engage building occupants:**

Engaging the building occupants at the initial stages of the monitoring cycle, as well as throughout the process, is key to minimising interference. A bespoke approach should be tailored to the specific user group, which should be clearly defined, in order to establish a sense of ownership. The following possibilities should be considered:

- Present the objectives, and potential payback, of the monitoring process to the users;
- Feedback findings at different stages throughout the project;
- Offer tangible rewards resultant from project gains; and
- Install notices alongside the equipment, describing the logger's function and purpose, and specifying the coordinator responsible for the particular site. This is particularly relevant in buildings often frequented by new or temporary users e.g. interns or guests.

- **Limit inconvenience and intrusion:**

Users will be more accepting of the monitoring equipment if it does not cause inconvenience. In limiting inconvenience to users, the following possibilities should be considered:

- Discuss the location of the equipment with the building users beforehand, in order to identify a site that does not cause inconvenience; and

- Identify a designated and isolated space for the equipment, which is in line with international standards (ISO 7726: 1998), that should not be used for any other purpose.

Invasion of privacy remains a barrier, particularly in that combined temperature and carbon dioxide data may lead to inferences on occupant behaviour (especially, for example, regarding activity levels). To mitigate the sense of intrusion, it is recommended that the aforementioned notices:

- Clearly define the objective of data collection;
- Highlight that participation is anonymous; and
- Offer an opt-out measure.

- **Mitigate interference:**

It is possible that interference may occur despite preventative measures. Actions should be taken to enable the researcher to address any interference as soon as possible in order to limit the impact to the study. The following possibilities should be considered:

- Allocate responsibility to a designated coordinator, and establish a channel of communication to highlight any issues that may arise;
- The coordinator should have a proprietary or management role within the building, and be aware of any upcoming works or engagements that may interfere with the data collection process;
- Develop an inspection schedule for the researcher and the coordinator to ensure that the equipment is checked regularly, as well as a system for recording interference; and
- Circulate instructions to building users to not disturb the equipment and alert the coordinator if interference is noted.

An integral aspect in designing an environmental monitoring programme should be the development of a strategy mitigating user-related issues. This approach is directed towards fostering a sense of ownership that should extend throughout the process of identifying eco-refurbishment solutions.

7.2.8 A Procedural Approach that Engages Occupants

By coupling an architectonic analysis with a study of occupant perceptions and behaviour, both immediate as well as long term measures to improve comfort and functionality at SnAP, and consequently environmental performance, were identified, as described in the previous sections (Sections 7.1.2.-7.1.6.). The value of this methodology in the effective selection process of appropriate interventions, is reflected by Akande et al. (2014), who promote an integrated approach to assessment. It is also reflected in European standards published in 2017 (EN16883: 2017), which promote the assessment of heritage value, building parameters, energy performance and user behaviour. However, the procedural approach derived through this research proactively engages occupants continuously in the eco-refurbishment of large-scale, mixed-use, heritage buildings, in order to obtain optimal results.

The information derived from the survey and assessment should be dovetailed to benchmark the context and identify measures to achieve energy savings. This is also recommended in European guidelines (EN16883: 2017). It is crucial that users should be actively engaged throughout this process in a two-way feedback loop, consolidating the arguments presented by Berg et al., (2017). Customised information and awareness raising will result in optimal user engagement, ownership of the project and a shift from learnt behaviour to environmentally conscious behaviour.

The results of the occupant survey highlight the willingness of users to compromise on comfort in order to preserve heritage, and their wish to learn about the building's history. In view of this, it is suggested that user involvement should be bolstered by information dissemination regarding heritage value and architectonic features. These findings are in line with those of Adams et al. (2014), who argue that such knowledge may influence users' perceptions of comfort in the historic building, and elicit more positive energy behaviour.

Having identified aspects which need to be addressed in the eco-refurbishment process, and highlighted immediate and long-term objectives, those measures which in no way impact on heritage value and may easily be implemented, should be tackled as first line goals. The initial feedback provided through the occupant survey enables more proactive user engagement in this regard. The selection and implementation of immediate objectives should be followed by post-intervention monitoring seeking to gain more focused data on the specific measures adopted. The different user groups identified through the survey require different motivations to influence behavioural improvement. Therefore, the feedback loop should be designed to target the relevant user cohort associated with the intervention.

Having implemented the first line goals, and re-assessed building energy performance and occupant behaviour, the long-term objectives should be reviewed. The advantages of the resultant set of objectives, potentially including new targets, should be evaluated against cost, impact to historic value and other relevant disadvantages. This may necessitate research and innovative design, as well as the intensive input of an inter-disciplinary team. Once again, the process should incorporate active user engagement, and be followed up with post-intervention monitoring, including environmental monitoring.

7.3 The Wider Study

7.3.1 Overview

In line with Research Aim 2 (Section 1.3), this study sought to examine the different aspects of the sustainable regeneration of built heritage (SRBH) in Malta and whether these support the sensitive, adaptive re-use of historic architecture. The results (Chapter 6) demonstrate that, in achieving this goal, three major areas must be addressed:

- Increase public awareness and affect behavioural change (know to do) (Section 7.3.2);
- Deliver the education, skills and competences to relevant stakeholders (know how to do) (Section 7.3.3); and
- Enable a supportive policy and procedural infrastructure for implementation (be able to do) (Section 7.3.4).

A number of cases exemplify the failings identified in the results and were used to develop a recommendation framework discussed in Section 7.2.5. An infrastructure to support this, and other recommendations, is presented in Section 7.2.6.

7.3.2 Supporting Positive Environmental Behaviours

The public's perceptions of the sustainable regeneration of built heritage and heritage buildings in Malta, and the level of awareness regarding the applications of passive environmental design strategies, were evaluated in line with Research Objective 2A. The results are discussed in this section, in the context of existing literature, and recommendations to address the identified barriers are presented.

7.3.2.1 Public Awareness and Attitudes

The general public is a primary stakeholder in the drive towards SRBH. Therefore, it is important to generate awareness in this area, as part of supporting positive environmental behaviour, particularly in the case of occupants and property owners/developers. The results of the case specific study benchmark the attitudes, expectations and behaviour of the occupants of San Anton Palace. The results of the wider study benchmark the attitudes and level of awareness of the general public. This research has, therefore, contributed to the body of knowledge on occupant perceptions and attitudes, addressing a gap in the literature identified by Fouseki and Cassar (2014). The respondents of the public questionnaire provided insight into the public's perceptions (Section 6.2.1), whereas two workshops and a focus group provided an understanding of how the public is perceived by stakeholders (Section 6.2.2).

The findings demonstrate that heritage buildings are valued on an aesthetic basis associated with their character, charm and history, and not for their environmental performance potential. Consequently, there is uninformed prioritisation of a particular aesthetic in a bid to increase value, resulting in poor quality insensitive design. Moreover, whilst there is the call for further conservation and regeneration, this is not matched by a readiness to live in heritage buildings. The deterrents to living in heritage buildings were found to be mainly related to a perceived:

- Burden on costs;
- Lack of comfort provision, including environmental comfort and adherence to modern requirements; and
- Difficulty in managing a heritage building project.

- **Cost**

Respondents of the public questionnaire identified cost as a major barrier. This challenge is also experienced in general building renovations across Europe (Moseley, 2016). Through this research, the burden on cost was found to be multifaceted. The initial cost of purchase is exacerbated by the subsequent expense of regenerating an often dilapidated property, which is seen as requiring a high level of maintenance in future. The findings also highlighted that there is an assumption that energy demand is greater in heritage buildings. This is in line with international studies, which illustrate a perception of these buildings as being energy inefficient (Boardman, 2007; English House, 2009). Moreover, the public do not associate maximising PEDS with increasing comfort and reducing energy costs. This was verified through the results of both workshops, which determined that energy concerns do not usually form part of the design brief. As a result, dependency on active means of environmental control increases and the potential for long-term savings is reduced. This highlights the importance of financial incentives specifically targeting eco-refurbishment in heritage buildings (addressed in section 7.2.2.3).

- **Comfort**

The findings identified conserving heritage features and achieving comfort as important goals of a heritage building project. However, whilst the former was perceived as being achievable, the latter was not. Participants with experience were more prepared to live in heritage buildings rather than contemporary buildings. This could be due to the fact that those with experience do not share the same notion regarding a lack of comfort provision and greater energy demand. It is, therefore, pertinent to incite a shift in the perceptions of those without experience in order to overcome this barrier. The SRBH is dependent in part on the general public being aware of the tangible and intangible benefits of heritage buildings, and their ability to provide a degree of comfort, and achieve modern requirements.

The perception of periti[14], as illustrated through the results of the focus group, is that the market is not geared towards integrating the concepts of environmental performance in the design brief for heritage buildings, and that the approach to conservation focuses on restoration of the structure and interior design. Since comfort provision and a reduction in energy demand are not perceived as deliverables in heritage building renovation, clients do not request or accept eco-refurbishment solutions as part of the development brief. This is substantiated by the workshop results, which highlight that interventions often impinge negatively on PEDS, as illustrated in The Wall Thickness Case (Case Example 6.2). It is further substantiated by results of the focus group, which indicate a strong dependency on active environmental control systems, even when not required, as discussed in The Hotel Conversion Case (Case Example. 6.1). The cause could be a translational-gap in the applicability of PEDS. This was illustrated by public questionnaire results which demonstrate that whereas participants could identify a particular feature as a PEDS, they were not able to apply the function of these features to an increase in comfort and energy efficiency. This is supported by the fact that respondents did not flag energy efficiency in heritage buildings as an area requiring further information and guidance.

- **Heritage Building Renovation**

Participants cited a number of deterrents to undertaking a regeneration project:

The Planning Authority: Respondents viewed undertaking a heritage building project with trepidation, citing the Planning Authority as the second major obstacle (following humidity) in regeneration. The Planning Authority is the only entity visible to the public with the role of conditioning and approving development, including interventions on heritage buildings. As a result, the blame for failures in the system is placed squarely with the Authority. It is viewed as being a major hindrance in adapting heritage buildings to achieve comfort and meet modern requirements, and considered to be ineffectual in protecting built heritage:

> *"Many old houses are left abandoned or demolished to make way for new build, rather than being restored".*

However, this perception of the Planning Authority as the main culprit is not necessarily well-founded. The onus for addressing environmental performance and heritage conservation is encompassed within the remit of the Building Regulations Office and the Superintendence of

[14] Perit: title of warranted architect and civil or structural engineer in Malta (Kamra tal-Periti, 2018b)

Cultural Heritage respectively. The existing procedure, however, does not incorporate consideration of eco-refurbishment of heritage buildings. This makes the case for a restructured policy and procedure framework (addressed in Section 7.2.4).

Skilled Craftsmen: Poor quality workmanship was regarded as a major obstacle, for example in restoration involving local stonework. This highlights a need for skilled craftsman, trained specifically in traditional techniques, and easily identifiable through a registry. A similar repository for appropriate materials and effective solutions would aid sensitive interventions in built heritage, particularly since this area was flagged as one requiring further information by both public questionnaire respondents, as well as workshop participants. This recommendation was welcomed by participants of the stakeholders workshop.

The Profession: Additionally, periti were seen as requiring further knowledge in order to effectively undertake a heritage building project. This perception was borne out by the results of the stakeholders workshop. When asked to comment on existing and expected comfort conditions, the feedback was superficial. This indicates that stakeholders are not particularly engaged with the specificities of this subject and, in effect, occupant comfort and behaviour are not generally considered in the design of the development proposal, as reported in both workshops. The result of the focus group corroborated this view and highlighted a failing to equip professionals with the relevant competences to eco-refurbish heritage buildings (addressed in Section 7.2.3). This is of serious concern since lack of comfort, together with energy costs, have been found to form major barriers to the sustainable use and preservation of heritage buildings (Carreón, 2015).

These deterrents are compounded by a lack of awareness by the client, whose choices are guided by aesthetic preference and cost-effective measures, even to the detriment of PEDS. The low level of awareness and knowledge was overwhelmingly emphasised as a major barrier to the SRBH, in line with the conclusions of literature (Carreón, 2015). Moreover, the results demonstrate that access to information and guidance documents is limited at both generic and specific levels. This problem was highlighted by the stakeholders workshop, which advocated the need for information to shift the value of built heritage from aesthetics and history, to also encompass environmental performance. Dissemination of customised information may be used as a tool to provide both long-term benefits and quick wins in this regard. It should feature in driving the market for the SRBH through the public by bringing awareness to the energy performance benefits of traditional architecture, and associated cost savings.

7.3.2.2 Dissemination of Information

Despite being able to recognise PEDS, the respondents of the questionnaire were limited in their ability to correlate these features with environmental performance in heritage buildings, such as passive cooling strategies. For example, participants were able to identify timber louvres and deffun roofing as mechanisms for environmental control. However, when subsequently questioned about the impact of their removal, this was associated to a loss of heritage. Similarly, whereas wall thickness and the internal courtyard were identified as PEDS, a reduction in wall thickness and roofing the courtyard were associated with an increase in indoor area. It should be noted that both these interventions were cited during the planning authority workshop as commonly featuring in proposals for heritage buildings, emphasising the urgency of addressing this matter. Dissemination of information offers the opportunity to help the public gain a basic understanding of the purpose of these features, and that there is still scope in enabling them to fulfil this purpose today.

A widespread awareness campaign, combined with bespoke audience-specific programmes is in line with the provisions of Article 12 of European Directive 2012/27/EU (Council Directive, 2018). However, literature has demonstrates that efficacy of information dissemination is dependent on the measures adopted (Rivas et al., 2016). Through this research, it is recommended that a two-tiered approach should start by delivering basic information to raise general awareness on PEDS in heritage buildings, linking them, and conscious behaviour, to the potential of reducing energy demand. This should comprise the three susceptibility points of economic, environmental and social benefits. It should also include children in the target audience, as supported by the literature which advocates educating future generations on the importance of sustainability (Carreón, 2015).

A second level of the campaign should incorporate more detailed information for those interested in gaining specific knowledge, for example owners of heritage buildings. France, for instance, offers assistance to owners understanding energy retrofits (Rivas et al., 2016). In Malta, a useful tool in this regard would be a home-owners guide, providing explanatory notes about PEDS, and how they can be maximised to improve environmental comfort. This recommendation is detailed in Section 8.3.1.

During discussions with stakeholders non-governmental organisations were omitted as a means of disseminating information to the public, despite having a powerful outreach. This may be due to the fact that environmental performance benefits are not yet considered as part of the remit in protecting heritage buildings. If this is the case, there is a twofold problem:

- The sustainability of the regeneration projects that they take on board; and
- An under-estimation of their compelling capacity to disseminate information to target audiences.

Dissemination of information was incorporated in this research through a public seminar coupled with the questionnaire, which generated widespread interest in this topic is outlined in Section 6.2.1.4. Its efficacy in achieving a change in the respondents' perceptions and understanding is outlined through the questionnaire results, which indicate that:

- Preference for heritage buildings increased (Section 6.2.1.1.);
- Goals of a heritage building project brief shifted positively (Section 6.2.1.2.);
- The relationship between heritage buildings and energy demand was re-examined (Section 6.2.1.2.);
- Recognition of the role of PEDS in improving environmental comfort increased (Section 6.2.1.3.); and
- Understanding of the impact of particular interventions improved (Section 6.2.1.3.).

It should be noted that this group of respondents was not representative of the wider population in their level of education. The majority of respondents (81%) had a tertiary education as compared with 21% of the wider population (Malta Independent, 2018). Even in this sample group, the importance of phasing the level of information delivered was highlighted through the respondents' reactions:

"Some of the talks were too technical, but overall the session was very good";
"I answered to the best of my knowledge as an educator coordinating environmental awareness".

This aspect must be considered in designing information dissemination measures.

Through this research, it is recommended that dissemination of information is utilised in order to foster a setting that enables positive environmental behaviour. A strategy aiming to link PEDS in heritage buildings to cost savings must be complemented with other mechanisms to motivate change and should address aspects of concern highlighted in the results, including feasibility measures.

7.3.2.3 Financial Incentives

Stakeholders advocated the use of economic measures as a means of creating interest in heritage building retrofits. Since the modern aesthetic is currently more in demand, incentives may encourage buyers to reconsider this preference. They could also motivate owners and developers to convert heritage buildings sustainably. Such incentives could take many forms, for instance tax rebates for eco-refurbishment which, coupled with the resultant energy savings, would make the niche market of heritage buildings more financially feasible. Another possibility would be to enable green heritage building retrofits to be covered by a loan that could later be repaid from resultant energy savings. Alternatively, the loan would have an attractive interest rate, as exists in the Netherlands (Carreón, 2015).

A high expenditure has been cited by questionnaire respondents as the main problem they associate with heritage buildings. This opinion is not unique to Malta. Heavy costs have also been recognised as a challenge and a barrier in other European countries, and the construction industry has been noting as failing to provide effective, cost-efficient solutions for eco-refurbishment (Moseley, 2016). Both the literature, as well as the results of this study, demonstrate that cost is the major determinant for sustainable interventions on heritage buildings (Carreón, 2015). Fiscal support would make this niche market more economically feasible and attractive.

Participants of the planning authority workshop endorsed the use of grants as a way of promoting heritage building retrofits, and more particularly the preservation of PEDS. This strategy has been used successfully to champion restoration initiatives (Example 6.3: The Case of the Maltese Timber Balcony). It has also been effective in promoting the use of renewable technologies (Example 6.4: The Case of the Photovoltaic Panels vs the Roof Gardens). The public has shown itself to be receptive to such schemes, which have had near full uptake, but their implementation could be much improved. A more systematic, evidence-based methodology should be adopted, which would integrate both energy performance and heritage conservation. Grants also present an opportunity to increase public interest and shift focus onto PEDS as an integral component of the heritage building typology, for instance, through the use of pamphlets accompanying and explaining the grant. Financial support schemes should be complemented with a monitoring process and feedback loop, generating key data regarding predicted and actual outcomes. The use of funding and grants as a driver to the SRBH is discussed in more detail through a prototype strategy derived as part of this study (Section 7.2.5).

It is worth noting that public historical buildings, such as San Anton Palace, which are generally given listed status, pose a greater challenge (e.g. mixed-use, cultural/historical value); one that would not be adequately addressed through generic grants and similar incentives. Moreover, given the complexity of architectural typology, eco-refurbishment interventions are generally much more restricted. It has been agreed that, in such circumstances, there is insufficient ‘added value’ to qualify for European funding (Carreón, 2015). The situation is further aggravated by the fact that listed buildings are exempt from European energy obligations (Akande et al., 2014). As a result, there is no pressure on local governments to allocate financial support to such initiatives. Consequently, publicly owned heritage buildings are left in a vacuum in terms of financial support for eco-refurbishments.

7.3.3 Facilitating Informed Decision-Making

The knowledge base, and level of awareness of stakeholders involved in designing and assessing interventions on heritage buildings, was appraised in line with Objective 2B. The low level of public awareness highlighted in Section 7.2 was found to span various groups and disciplines (Wismayer et at, 2019). Stakeholders of the SRBH, particularly students and young graduates, professionals, and policy-makers and operators, were found to lack an understanding of the benefits of PEDS inherent to heritage buildings, and of the implications of particular interventions on environmental performance. This is an area of concern, since improving the energy performance is not necessarily a simple task (Böttcher, 2014a).

Previous literature has highlighted the successes of education and training programmes as valuable and effective tools in reaching energy-saving goals (Warburton, 2003; Roulet, 2006; Altomonte et al., 2014; Hardin et al., 2016). However, the results of this research clearly demonstrate the need for deeper education at varying levels, including training programmes, targeting the stakeholders in the field of SRBH in Malta.

7.3.3.1 Formal Education and Continued Professional Development

- **Basic Education**

In delivering an education on sustainability, the literature (Ibrahim et al., 2007; Altomonte et al., 2014; Gulay Tascı, 2015) encourages the inclusion of subjects not traditionally associated with this area. In view of this, principles of sustainability should be embedded in curricula from primary education through subjects such as local history; e.g. develop the student’s appreciation for the multifaceted value of architecture through examples of vernacular PEDS.

- **Under-graduates**

Internationally, problem-driven, solution-oriented methods, such as case-based learning, have been shown to address the challenges of teaching in sustainability (Hardin et al., 2016). However, the Maltese architectural education system remains traditional in nature, despite research that questions the adequacy of such programmes in meeting modern requirements (Charalambous and Christou, 2016). Conventional teaching methodologies focused on information delivery through lectures, discussions, problem sets and written assignments do not support the development of integral competencies for professionals in the SRBH. Therefore, the local academic programme addressing heritage conservation and the environmental performance of buildings should better focus learning outcomes (Altomonte, 2014). Students may be supported in effectively intervening on vernacular architecture through contemporary teaching methods, such as workshops, e-learning tools and site work, that centre on a case-based, problem-driven approach to deep learning.

- **The Profession**

Mentoring would support young graduates in developing skills and competences in the practice, as suggested in the literature (Ibrahim et al., 2007). Through this research, gaps in the educational framework have also been identified at a professional level. For example, the results of the focus group noted that periti are, in the main, unaware of their legal responsibility to certify adherence to minimum energy performance standards, and do not have the competence to fulfil this role. Additionally, the results indicate that even informed members of the profession are not fully cognisant of the application of certain legal obligations to heritage buildings, for example the necessity to provide an Energy Performance Certificate, or to comply with minimum energy performance regulations. Continuing professional development may be key in addressing this gap. However, existing legislation governing the profession does not oblige periti to undertake continuing professional development (Periti Act, 2010). It is being recommended that a structured framework of obligatory continuing professional development courses, comprising different forms of learning is developed with the objective of:

- Updating the profession regarding new (or changes to) legislation and responsibilities; and
- Addressing a wide range of topics with the intention of improving professional practice.

7.3.3.2 Training

Continued professional development should be coupled with specialised training to produce experts competent to undertake particular roles and responsibilities, such as periti qualified to certify compliance with minimum energy performance requirements in heritage buildings. These results highlight the need for multi-level training courses targeting different stakeholders in the field of SRBH to develop specific skill sets and practical application. In line with the provisions of Article 17 of European Directive 2012/27/EU (Council Directive, 2018), member states have taken measures to provide training in the energy sector. Germany, for instance, offers robust vocational training for service providers to develop professional competence and take on challenging tasks in the field (Rivas et al., 2016).

Both workshops emphasised the need to offer training for assessment officers at the Planning Authority in order to address the lack of expertise in the field of SRBH. The focus group considered existing training programmes for assessment officers to be superficial, calling for a thorough review of the system. However, for such training to be effective, their role must be more clearly defined, as described in Section 7.2.4). In the interim, best practice examples may be used as a quick win to fill current gaps in the system.

Energy performance assessors are another stakeholder that stands to benefit from training. This group are not currently supported in their role of making recommendations to improve energy performance in heritage buildings, for example by maximising the impact of PEDS. This should ideally be a first line approach before proposing other solutions, such as renewable energy sources. Additionally, training for craftsmen such as stonemasons would safeguard declining expertise in traditional trades and techniques. It would also improve the quality of workmanship, as was the case with the vernacular timber balcony when courses were offered to carpenters seeking to obtain qualification (Example 6.3: The Case of the Maltese Timber Balcony).

As a result of the lack of specialised training courses offered in this area, periti, assessment officers, energy performance assessors and interior designers, all of whom play an active role in the field, are not supported in developing skills and competences in the SRBH. It is, therefore, being recommended that continuing professional development is coupled with a well-designed multi-level training strategy, to address gaps in skill sets and competencies in this field through an organised framework. This may range from online training and free e-learning courses to seminars on specific topics or case presentations, as highlighted by Rivas et al. (2016).

7.3.3.3 Knowledge Sharing and Knowledge Transfer

Knowledge sharing and knowledge transfer may be used as tools to drive the SRBH through good quality design and the eco-refurbishment of heritage buildings. This recommendation was welcomed by the workshop participants. In the absence of sufficient evidence-based data, best practice examples may be used as a practical means of knowledge sharing to enable informed decision-making through the experience of colleagues. However, both effective and ineffective solutions should be collated and shared. According to the participants of the stakeholders workshop, professionals hold back from reporting negative experiences or mistakes, probably from fear of embarrassment and potential consequences. There is currently no means of ensuring confidentiality and anonymity. To overcome this obstacle, sharing platforms should adopt an overtly anonymous no-blame culture to data collation and dissemination.

In contrast, architectural awards schemes inaugurated in recent years could potentially provide an effective means of highlighting best practice examples. The Malta Architect Awards, first sponsored by the Planning Authority in 2016 (Planning Authority, 2016), and the Emanuele Luigi Galizia Awards launched by the Chamber of Architects and Civil Engineers in 2018 (Torpiano, 2018), could both be developed to drive good quality design in eco-refurbishment of heritage buildings. In future, the award schemes should give recognition to projects that encompass the principles of SRBH, rather than only considering heritage conservation and environmental performance as two separate categories or criteria. For example, the 2018 Malta Architect Awards featured a category for rehabilitation and conservation, and a separate award for sustainable development, but did not amalgamate the two concepts (Planning Authority, 2018b). In addition, in order to ensure effective dissemination to stakeholders, in particular to the profession, but also to the public, details on the winning projects should be accessible online. This is not the case for either of the awards schemes. The Emanuele Luigi Galizia Awards did enable knowledge transfer through public presentations of both architectural projects and research dissertations, nominated in different categories. This research highlights the need for further dissemination of research findings through the Faculty for the Built Environment, for example, in the form of symposia.

Through the results, two knowledge sharing and knowledge transfer mechanisms were identified, as described in Section 6.3.4. Both could be further developed to encompass the recommendations of this research (Section 8.3.1).

The Periti Discussion Board, a closed social media group referenced during the stakeholders workshop, is an example of an established mechanism that could be used to exchange information. It was cited multiple times as an ideal platform for knowledge sharing, utilised frequently by periti to ask questions and discuss topics. The popularity of the discussion highlights the demand for such a tool. However, whereas the concept of posing questions and discussing experiences through professional-to-professional exchange is one that should be encouraged, this platform may only be suitable for this particular type of knowledge sharing. Despite being a go-to source to discuss practical issues in an informal forum with colleagues, it is restricted by the environment under which it is operated. The fact that products and materials are not shared through the platform may be a result of the responsibility taken for recommend. In this context, participants called for a more structured knowledge sharing mechanism that would enable dissemination of information regarding products and materials, as well as projects and practical experiences.

The Ecobuild website (Government of Malta, 2013), administered by the Building Industry Consultative Council, was referenced in the stakeholders workshop as an "online tool and helpline on green building technologies and renewable energy in the local context". It features a repository of locally available products and services, and showcases case studies and financial incentives. However, all information is heavily focused on new builds, with no consideration given to heritage architecture. This highlights the importance of extending the nature of disseminated material to incorporate the latter typology. Moreover, since the website is dependent on the submission of best practice examples, the profession should be encouraged to contribute to the platform, potentially through social media promotion.

The limited ability to share and transfer knowledge, as identified through this research, is a barrier to developing a better understanding of PEDS and their role in the SRBH. In this context, professional-to-professional sharing was highlighted as key to the development of a robust knowledge base. It is, therefore, recommended that best practice examples are collated within a structured online repository. The examples should be based on local case studies, as well as case studies from other Mediterranean countries, illustrating successful and unsuccessful eco-refurbishment interventions on heritage buildings. This should be complemented by organised study tours of specific projects. These have been found to be an effective tool in transmitting the application of adopted principles and solutions in a practical setting (Moseley, 2016). However, further research on heritage building fabric and physics, as well as effective and ineffective solutions is imperative in supporting evidence-based decision-making.

7.3.3.4 Research Addressing Knowledge Gaps

Although professional-to-professional knowledge transfer and sharing is improving through online platforms, it cannot address gaps in the local understanding of heritage buildings such as those identified through this research, including solutions to maximise energy performance through PEDS. The need for such studies has been recognised internationally (EFFESUS, 2016; URBACT, 2019), but locally, the gap between heritage conservation and energy performance has not been bridged. This acts as a barrier to formulating policy, motivating clients and successfully retrofitting heritage buildings. Decision-making is generally based on anecdotal evidence and practical experience rather than scientific research. This is particularly evident in the case of periti, planning officers and policy-makers. Moreover, when a retrofit solution was discussed during the stakeholders workshop, differing opinions demonstrated the unreliability of anecdotal information (Section 6.3.3.). This reinforces the need for evidence through structured research, which is then shared within the stakeholder groups and continuously developed.

The challenge presented by heritage buildings in jointly addressing energy efficiency, heritage conservation and user comfort is acknowledged in the literature, as is the need to discover solutions to this (Böttcher, 2014a). Information gained through anecdotal cases and practical experience, and backed by building physics principles, should be used as the hypotheses for future research culminating in robust studies. There should be concrete measures to facilitate a shift towards validated data, and to enable proactive dissemination back to the industry. Currently, academic research in the field of SRBH is neither systematic in targeting the identified knowledge gaps, nor disseminated. This may be due to the association-gap between heritage conservation, energy performance and user comfort, and the lack of a structured framework outlining areas of priority in this context. Educational institutions should make a commitment to include this area as a speciality of research at all levels, from undergraduate to post-doctoral level, in order to strengthen this field. The arrangement should support cross-disciplinary research, in line with the cross-disciplinary teaching promoted in the literature (Ibrahim et al., 2007). Streamlining research would encourage studies on environmental performance of heritage buildings that encapsulate the pertinent aspects in SRBH and equilibrate occupant comfort with use and heritage value. Additionally, it would facilitate investigation of the knowledge gaps identified through this study (Section 6.3.3.).

For example, humidity was ranked as the top obstacle in heritage building projects by respondents of the public questionnaire. This is not surprising given the local climate (Buhagiar et al., 2007). However, their concern about this issue may also be due to the fact that whereas the public has access to means of addressing light, heating and cooling through active environmental control systems, there are no effective, evidence-based and easily available solutions to addressing humidity. This is one of the areas of priority highlighted through this research, which must be further investigated in order to support a successful drive towards SRBH. Others include:

- Investigating sensitive methods of aligning PEDS in heritage buildings, and their application, with modern comfort standards and lifestyle requirements. Studies, both technical and design oriented, should strive to find innovative ways of maximising advantages whilst minimising disadvantages. For example: the use and maintenance of timber louvers in the context of a modern lifestyle;
- Developing an understanding of the collective impact of PEDS on the fabric of heritage buildings. Studies should analyse the resultant effect of interventions on the performance potential of PEDS. For example: analysis of the impact of draught-proofing apertures on humidity levels;
- Assessing the life-cycle cost savings achieved through eco-refurbishment interventions in the local context. Data should be collated to correlate potential energy cost savings resulting from eco-refurbishment, enabling periti to validate their proposals and motivating the public through informed decisions. For example: assessment of the reduced cooling demand, and corresponding cost saving, following the removal of a glass roof over an internal courtyard; and
- Validating the national benefit of financial incentives. The national benefit of grants and tax rebates should be compared with the corresponding national expense. Validation should also consider qualitative benefits and drawbacks.

Specific research may be sponsored by non-academic institutions, for instance the Building Regulations Office. These could include post-evaluation studies focusing on energy savings following heritage building retrofits, as has been described by (Cabeza et al., 2018). Project-specific studies to investigate technical solutions amalgamating the concepts of heritage conservation, energy performance and building use have been undertaken successfully across Europe. This is highlighted by the best practice examples emerging from the 3ENCULT website (3ENCULT, 2014).

There should be a structured plan enabling findings to reach the operators. In this context, the university should proactively encourage its graduates to publish and disseminate their research, as part of the course structure, for example, through a faculty-run symposium or an abstracts booklet. Additionally, where relevant, students should be encouraged to produce pamphlets or brochures to be disseminated directly to stakeholders through appropriate channels. The findings of this research have been proactively disseminated, through mechanisms presented in Sections 8.3.2 and 8.3.4, generating interest from the public as well as other stakeholders.

7.3.4 A Supportive Infrastructure

In line with **Objective 2C** the existing design and assessment framework was evaluated to determine whether it targets and supports all relevant parameters in heritage building interventions. The results are discussed in this section and recommendations to address the barriers identified in legislation and policy (Section 7.2.4.1), the regulatory infrastructure (Section 7.2.4.2) and standards, guidelines and good practice (Section 7.2.4.3).

7.3.4.1 Legislation and Policy

- **Legislation**

This research demonstrates that the subjects of energy and heritage are addressed through legislation and policy as completely independent concepts, and in a manner that sometimes gives rise to incongruity in heritage builds. Legislation on assessing and maximising energy performance (Council Directive, 2010; Council Directive, 2012; Council Directive, 2018; Building Regulation Act, 2018], as well as measures to reduce energy demand (Rivas et al., 2016) give no consideration to the challenges posed by heritage buildings, as recognised elsewhere in Europe (Böttcher, 2014a). The main differentiation between heritage and contemporary buildings is in actual heritage value, for example through scheduling.

Energy performance legislation, although not specific to heritage, may also apply to this typology in particular instances. Energy regulations introduced as a result of European directives may not be implemented in the spirit that the international legislator intended. Examples include certification of compliance with minimum energy performance standards, and the provision of an Energy Performance Certificate. The introduction of the latter, at the very minimum, could have the potential to raise awareness of the significance of a building's energy efficiency. The potential of reducing running energy costs, and increasing a property's value, should have been the logical development to this concept. However, in Malta, the requirement to provide an Energy Performance Certificate was only enforced hurriedly in 2018 (Council Directive, 2018). According to the planning authority workshop participants, it is perceived as an unavoidable, bureaucratic obligation, and has not succeeded in generating interest in a building's energy efficiency:

"For the time being, it's almost an academic exercise… It is a bureaucracy, which emanates from a European directive."

Moreover, the methodology of the assessment in relation to the structure of the building was questioned by stakeholders:

> *"The concept of the EPC is more related to the efficiency of building services systems than of the performance of the building fabric."*

There is a need to take proactive measures through the formulation of national legislation and policy on SRBH, that recognise the value of PEDS when addressing heritage conservation, and incorporate aspects related to culture and requirements. In the absence of such a legislative infrastructure, decisions in this area have been fragmented and mainly driven by European obligations focusing generically on energy performance. This is demonstrated in Example 6.4. (The Case of the Photovoltaic Panels vs the Roof Garden), which was aimed at meeting renewable energy targets set by the European Union, without any studies regarding predicted lifecycle savings, or monitoring. The case illustrates that even high-level governmental decisions are not evidence-based, validated or audited. In the absence of a supportive infrastructure, there is no accessible information regarding whether the overall cost of the initiative justifies the return, and in case of urban conservation areas, the impact on the streetscape. Neither can there be an objective comparison of alternatives.

The lack of specific legislation and policy in this context is broadly evident, not only in Malta but also in other countries (Carreón, 2015). This situation may perhaps have been conditioned by the Energy Performance of Buildings Directive (Council Directive, 2010), which does not associate sustainability goals to listed heritage buildings (Litti et al., 2013). In their recently published paper, the Chamber of Architects and Civil Engineers call for a thorough review of building regulations, and present a framework on which this legislation may be based (Kamra tal-Periti, 2019a). This research contributed to their proposal in the context of sustainable regeneration of heritage buildings. As a result, the document highlights the importance of formulating specialised regulations for vernacular architecture, which are currently unavailable.

This absence was highlighted by several stakeholders through this study. Respondents of the public questionnaire perceived the state of conservation of built heritage in Malta to be poor:

> *"Misguided policies which result in more harm than good".*

Participants of the planning authority workshop highlighted a lack of clear policy appropriately addressing the links between heritage buildings and energy conservation. Stakeholders emphasised that, whereas minimum standards are defined for contemporary buildings, these are not available for heritage buildings, leaving the profession at a serious disadvantage. Additionally, even periti who are familiar with the legislative and policy infrastructure were not entirely clear regarding the applicability of certain energy performance obligations to heritage buildings. This was illustrated during the focus group, where participants discussed the publication of the Energy Performance of Building Regulations 2018 (Building Regulations Act, 2018), relating to the transposition of Directive 2010/31/EU. The notion that most periti are unaware of the obligations defined in this legislation highlights major deficiencies in the system.

It is also evident that the existing framework does not adequately support the appropriate handling of incoming legislation and any associated change in roles and responsibilities. New legislation and policy should be developed through appropriate channels of communication with relevant stakeholders, resulting in effective consultation. Implementation should be complemented with technical guidance where necessary, to enable correct execution by operators. Moreover, there should be sufficient preparation time allowing for operators to be proactively informed of their new responsibility, and trained through continued professional development, or other means.

National legislation must adhere to European Union obligations, and encapsulate the principles of international charters to which Malta is a signatory. However, it should also cater to the specificities of the local context. This study has sought to identify and review the challenges faced by the SRBH: these may subsequently be addressed in legislation and policy.

- **Policy**

As designated in council directive 2010/31/EU (Council Directive, 2010), government is obliged to lead by example in the eco-refurbishment of public buildings. Since Malta has a rich stock of heritage buildings, this typology should form part of this initiative. Government also has a concomitant responsibility to formulate policy targeting a more energy efficient building stock, which in the case of heritage buildings is clearly lacking. Such a policy should seek to overcome challenges faced by the SRBH, such as those identified in this study.

It should also be the springboard for devising informed measures that may be taken to achieve the objective of SRBH. In view of the fact that the retrofitting of heritage buildings presents greater difficulties (Moseley, 2016), the need for specific measures and guidance in this area is crucial. Moreover, it is government's role to assure the efficacy and feasibility of policy and policy measures (Rivas et al., 2016). This includes the provision of an effective regulatory infrastructure.

Locally, energy performance is only considered through generic policy, giving rise to an ambivalence that has been overcome elsewhere in the Mediterranean. This was highlighted, for instance, through the planning authority workshop, when restrictions on the material and configuration of apertures in specific urban conservation areas was discussed. In contrast, the case studies presented as part of the 3ENCULT project illustrate how this conflict may been resolved. For instance, in Bolzano, Italy, a 12th century building was retrofitted with energy efficient box-type windows (3ENCULT, 2014).

Despite repeated attempts to understand the existing policy direction regarding SRBH, in the main, policy-makers and operators resisted the concept of amalgamating heritage and energy. Additionally, whereas stakeholders recognised the importance of considering user needs, they related this to re-use, rather than adaptive re-use which was only given cursory mention. This highlights the importance of shifting perceptions towards a new approach. The transition towards valuing energy performance in heritage building interventions should be directed by a clear message spearheaded by government through policy. The main thrust of this policy should be to balance heritage conservation, environmental performance and user requirements emanating from the building's use, depending on the particular case.

A robust policy framework would provide stability and facilitate informed decision-making. It should be complemented by a monitoring system, which would track progress and generate data delineating the results emanating from policy and policy measures (Moseley, 2016). However, a revised legislative and policy infrastructure will not work effectively within the existing framework of three distinct entities, namely the Planning Authority, Superintendence of Cultural Heritage and Building Regulations Office. The Building and Construction Regulator, proposed by government (Malta, 2018) and supported by the Chamber of Architects and Civil Engineers (Kamra tal-Periti, 2018d), presents the opportunity to formulate national policy which will act as a driver for the SRBH in Malta through a collective and collaborative effort.

7.3.4.2 Regulatory Infrastructure

In order for legislation and policy to be successfully implemented, a robust and effective regulatory infrastructure is crucial. This research demonstrates that the existing system for conditioning and assessing proposed interventions on vernacular architecture is fragmented and ineffective. Heritage conservation cannot be secured through the provision of an abridged Restoration Method Statement (Kamra tal-Periti, 2018e), and energy performance cannot be maximised through the provision of an Energy Performance Certificate, or the allocation of an area on-site for renewable technologies. Moreover, the assessment of these aspects by independent bodies, in the absence of adequate communication channels, does not foster an environment of effective cross-disciplinary consultation. Fouseki and Cassar (2014) argue that heritage conservation, environmental comfort and feasible energy retrofits must be balanced through interdisciplinary communication and compromise. This research has concluded that use and user comfort must also be equilibrated as a key determinants in this process, and that policy-makers, operators, academics and non-governmental organisations should contribute to an evidence-based decision-making infrastructure.

Currently, there exist gaps in the assessment process, whereby the consideration of use is not linked with the specificities of the heritage building, but rather the urban area. Moreover, the findings of the stakeholders workshop and the focus group, as well as the respondents of the public questionnaire, identified the Planning Authority as a major obstacle in retrofitting heritage buildings. In the case of the latter group, this is probably because the Planning Authority is the only visible body deciding on development applications. In effect, this perception is correct, as outlined in Section 3.5. However, in reality, the decision to approve or reject an application is reached following consultation with a number of external entities, including the Superintendence of Cultural Heritage.

Every development application, including new builds, is forwarded to the Superintendence of Cultural Heritage. Almost 12,000 applications were validated by the Planning Authority in 2018, a 35% increase from 2016 (Planning Authority, 2019b). This manifests a situation whereby the Superintendence, which has severely limited resources, is completely overwhelmed, and unable to adequately fulfil its role. Moreover, although the interaction between the two entities is referred to as consultation, the views submitted by the Superintendence are simply accepted by the planning officer and put to the perit. Conversely, energy performance is given no consideration at all in the assessment of any application received by the Planning Authority. The participants of the planning authority workshop attributed this to the fact that energy performance of buildings is the remit of the Building Regulations Office, and therefore outside of their responsibility. However, there is no reason why this entity should not be involved in the assessment process together with the Superintendence of Cultural Heritage.

7.3.4.3 Standards, Guidelines and Good Practice

Concerns were raised by stakeholders regarding the lack of specific standards and guidance on retrofitting heritage buildings. The usefulness of best practice examples was also highlighted in this regard. The argument for provision of evidence-based standards, guidance and good practice examples is strengthened by the complexities presented by heritage buildings in eco-refurbishment, as well as the recommendation to adopt a case-by-case performance-based approach which attributes consideration to use. Other countries have taken a proactive approach in adopting national guidelines for retrofitting historic architecture, and there is a movement towards the formulation of European standards and guidelines (Böttcher, 2014a).

Currently the profession in Malta is mainly dependent on anecdotal information and practical experience. Generic standards and guidelines become unclear when applied to heritage buildings, whilst those relating to conservation require a less rigid and more open approach. None exist which amalgamate energy and conservation in this context, thereby sometimes resulting in contradictions. Planning officers adopt a policing approach to assessment and take on an attitude of encouraging or discouraging any particular heritage building intervention based on an elemental understanding of its impact. In this regard, their direction has been shown to generally centre on preservation, with notable preference for reversible interventions, and little consideration of environmental performance, as illustrated through Case Example *4.1*. (The Courtyard Case). The Courtyard Case indicates the reality of how similar applications are adjudicated. It demonstrates the need to foster an environment were clear, transparent and specific standards, guidance and good practice examples are accessible to support the perit, as well as the assessment officer. In the context of heritage buildings, these should identify PEDS, highlight their function and specify that this function should be maximised as a first line option. This is the only forum in which a case-by-case performance-based assessment approach will work effectively, enabling both parties (assessor and perit) to coordinate and raise the standard of submitted applications.

Existing standards and guidelines when applied to heritage buildings have been shown to manifest incongruities. One example, highlighted through this research, centres around the Restoration Method Statement. This document may be requested by the Planning Authority as part of an application for proposed interventions on a heritage building. Its aim is to ensure good practice in each particular case through a pre-determined and customised restoration methodology, based on specified Terms of Reference. However, further to complaints from its members, the Chamber of Architects and Civil Engineers recently issued a directive (Kamra tal-Periti, 2018b) instructing periti to ignore and report requests from the Planning Authority to retract a detailed Restoration Method Statement and submit a dictated, abridged version instead. This is symptomatic of the type of failures in the system, and the resultant frustration of clients towards both periti and the Planning Authority.

Ambiguity is also evident in Case Example 6.3, which discussed the grant scheme for restoration of timber balconies. The Planning Authority adopted a proactive and positive approach to this measure by drafting standards and guidelines for craftsmen, and providing funded training, before issuing the grant. In this way, detailed standards and guidelines, tied with training and fiscal support, resulted in the widespread maintenance/restoration or, where necessary, replacement of a PEDS. However, the provided standards and guidelines seriously limit and hamper innovation by specifying that only traditional materials and techniques are used, and the design and proportions of the balcony should be identical to the original, even in the case of replacement (Planning Authority, 2018a). The missed opportunities of this case are described in more detail in Section 7.4.2.1. However, what is pertinent to note in relation to the standards and guidelines is that, in practice, the restriction on alterations oppose the incorporation of green retrofit measures also mentioned in the guidance notes that: “The scheme seeks to fund most of the costs of restoration works and retrofitted green initiatives compatible with the conservation status of the property”.

Further incongruity is evident in Case Example 6.6, which benchmarks the Planning Authority’s approach to the assessment of applications proposing interventions on heritage buildings. In this case, senior management highlight how, after receiving approval following several recommendations for refusal, the project went on to win an award for rehabilitation and conservation, sponsored by the Authority itself. The initial and repeated negative reception to the proposal was based on it non-compliance to design standards and guidelines. Yet, the same design was later applauded for innovation, creativity and sensitivity to the vernacular aesthetic: quoting the awarding body “The entry was commended for the boldness and simplicity of its concept. The design solution was sensitive in relation to the handling of the existing building, its surrounding context, and synergy with the different architectural styles of the buildings surrounding it” (Planning Authority, 2017). Whilst offering clear direction, standards and guidelines should also support the assessment and use of innovative design concepts and materials (Moseley, 2016). Moreover, the approach to conservation should be open to the integration of energy performance as well as to the intended use of the building: “It is now not only a question of how to conserve a building, but also of how to further develop it” (Böttcher, 2014a).

This calls for preliminary standards and guidelines to be issued urgently, particularly where the governing principles are evidence-based, or based on generally accepted conventions. Academic research and operational findings should then be used to formulate clear, specific and evidence-based standards and guidelines directing the design and assessment process. These should also enable the assessment and use of innovative solutions, as advocated in the literature (Moseley, 2016). The provision of standards and guidelines is affirmed by the Chamber of Architects and Civil Engineers through the recently published consultation paper of the building and construction framework (Kamra tal-Periti, 2019a). There should be responsibility placed on an appropriate entity to review these guidelines periodically. This is particularly pertinent where research has unveiled new data.

In anticipation of the provision of detailed and thorough documents, good practice examples should be provided by the Planning Authority, and the Chamber of Architects and Civil Engineers, through collaborative effort, in order to guide the profession and the public in the interim. For instance, successful nominations from existing award schemes, sponsored or hosted independently by both entities, may be collated and disseminated as a precursor to a more structured system. This research highlights the need for an ever-developing, easily accessible best practice repository, facilitating informed decision-making, implementation and post-intervention monitoring.

7.4 Recommendations, Research Outputs and Impact

This section outlines the research contributions, comprising recommendations, academic publications, practice-based outputs and efforts to increase awareness on the sustainable regeneration of built heritage.

7.4.1 Recommendations

Through this research, various recommendations were developed and presented during the discussion. These fall into two main categories:

- Macro-scale programmes to facilitate the sustainable regeneration of built heritage. These incorporate contributions towards improved public awareness, alternative education techniques and revisions to the legislative and regulatory infrastructure; and
- Micro-scale approach to heritage building projects. These comprise the provision of best practice guidelines for intervening on heritage buildings.

Collectively, the recommendations target a variety of stakeholder groups, including policy-makers and operators, the inter-disciplinary design team, as well as the public, heritage building owners and occupants.

Recommendations of the Wider Study (Macro)
Further to the findings of this research, recommendations have been put forward to facilitate the sustainable regeneration of heritage buildings through sensitive adaptive re-use which enables the conservation of historic architecture and informed interventions that consider environmental performance. These are summarised below:

- Supporting positive environmental behaviour, centred on combined and focused use of information dissemination campaigns and financial incentives (Section 7.3.2);
- Facilitating informed decision-making through a developed educational system and continuing professional development, training, knowledge sharing and transfer, and a structured strategy to address knowledge gaps using research and innovation in specified areas (Section 7.3.3); and
- Enabling a supportive framework for the design and assessment of heritage building interventions, including targeted legislation and policy, a tailored regulatory infrastructure and targeted standards and guidelines (Section 7.3.4). This framework should be bolstered by a revised regulatory infrastructure, which addresses existing shortfalls: a proposed system has been developed as part of this research and is presented as future work to be validated (Section 7.6.2.1).

Recommendations of the Case- Specific Study (Micro)
Further to the findings of this research, recommendations have been put forward to exploit the inherent environmental performance potential of San Anton Palace by maximising occupant comfort and functionality, and enabling environmentally conscious behaviour. These are summarised below:

- A room-use designation plan and long-term restoration strategy, developed by a cross-disciplinary team (Section 7.2.2);
- The identification of specific areas where there is potential for environmental performance improvement, mainly related to passive environmental design strategies, room layout, past interventions and lost traditions (Sections 7.2.3, 7.2.4 and 7.2.6);
- The provision of benchmarks, and a detailed architectonic survey, which may be developed to enable informed decision-making and post-intervention monitoring (Section 7.2.5);
- Best practice guidelines on a user-centred approach to environmental monitoring of in-use buildings (Section 7.2.7); and

- A proposed and validated methodology for the eco-refurbishment of large-scale, mixed-use, heritage buildings that proactively and continuously engages occupants (Section 7.2.8).

Through this research, overlapping aspects of the sustainable regeneration of built heritage infrastructure were identified and holistically amalgamated to develop a prototype framework. The framework, presented as future work to be validated (Section 7.6.2.2), exemplifies how key concepts may be harmonised to provide a more effective result. The facets considered include: innovation and research; standards, training and craftsmanship; financial incentives and auditing.

This research sought to address the fragmented approach to the sustainable regeneration of built heritage through the above recommendations. The Sustainable Regeneration of Built Heritage Platform, developed through this research, aims to drive forward these proposals. Presented as future work to be validated (Section 7.6.2.3), it comprises a mechanism for the establishment of a stakeholders' network, enabling effective and structured knowledge transfer and sharing, both locally and internationally, and supporting and coordinating the implementation of the above recommendations.

7.4.2 Academic Outputs

Academic outputs emerging through this research are presented in Table *7.1*. These include a published and planned journal papers, as well as published and accepted conference papers. A selection of these publications is presented in Appendix E.

Table 7.1: Publications emerging through this research

Published Journal Papers	
Title	The Role of Education in the Sustainable Regeneration of Built Heritage: A Case Study of Malta
Journal	Sustainability (2019)
Authors	A. Wismayer, C. S. Hayles, N. J. McCullen
Planned Journal Papers	
Title	Sustainable regeneration of built heritage: A national strategy for Malta
Journal	Targeted to: Journal of Cultural Heritage
Title	User perceptions and occupant comfort: A study of a Maltese palace
Journal	Targeted to: Sustainability
Published Conference Papers	
Title	Sensing and Sensability: The case for low-cost environmental sensors
Conference	8th International Conference on Structural Engineering and Construction Management. 7-9 Dec 2017
Authors	T. R. Lovett, E. Gabe-Thomas, S. Natarajan, M. Brown, J. A. Padget, M. Vellei, A. Wismayer, C. E. Russell, N. J. McCullen
Title	Sustainable interior environments for historic buildings: A case study of the Presidential Palace of Sant' Anton, Malta
Conference	World Sustainable Built Environment Conference Hong Kong Transforming Our Built Environment through Innovation and Integration: Putting Ideas into Action. 5-7 June 2017
Authors	A. Wismayer, C. S. Hayles, N. J. McCullen
Title	Occupant behaviour at the Presidential Palace of San Anton, Malta: A study supporting the development of a methodology to enhance energy efficiency in heritage buildings
Conference	SBE16: Europe and the Mediterranean Towards a Sustainable Built Environment. 16-18 March 2016
Authors	A. Wismayer, C. S. Hayles, M Lawrence, N. J. McCullen, V. Buhagiar
Accepted Conference Papers	
Title	Field assessment of heritage buildings: A study of Maltese palace
Conference	SBE19 Malta International Conference: Sustainability and Resilience 21-22 Nov 2019
Authors	A. Wismayer, N. J. McCullen, C. S. Hayles
Title	Influencing behavioural change: An integral measure in the sustainable regeneration of built heritage
Conference	SBE19 Malta International Conference: Sustainability and Resilience 21-22 Nov 2019
Authors	A. Wismayer, C. S. Hayles, N. J. McCullen

7.4.3 Practice-Based Outputs

7.4.3.1 Stakeholder Meetings and Associated Outcomes

In line with the recommended Sustainable Regeneration of Built Heritage Platform, this research has aimed to establish and grow a network of key stakeholders, and coordinate their efforts towards the sustainable regeneration of built heritage. It has also aimed to increase awareness through knowledge transfer. The resultant practice-based outputs, which are described below, include committed future outcomes that will continue to drive the sustainable regeneration of built heritage.

Chamber of Architects and Civil Engineers (Kamra Tal-Periti)
This research has contributed to a public consultation paper on the building and construction regulation framework. Aspects related to the sustainable regeneration of heritage buildings, as well as recommendations of this research, have been included in the published document (Kamra tal-Periti, 2019) launched on the 17th May 2019, and subsequently presented to government, and the opposition.
Additionally, the KTP Council agreed to:

- Allocate a permanent section for Regeneration Projects in the KTP Journal in order to build up a database of good practice examples;
- Include the sustainable regeneration of built heritage as one of the areas of continued professional development courses, once the legislative framework is established and made obligatory to practising periti[15]; and
- Establish a Charter for periti who subscribe to a higher quality of design in sensitive and sustainable interventions on Heritage Buildings.

Malta Business Bureau (MBB)
Further to an invitation to present the findings of this research, the MBB agreed to assist in a crowd-funding initiative aimed at supporting the development of a case-based learning heritage building retrofit project. This will be coupled with an awareness campaign, designed to promote the crowd-funding initiative and influence behavioural change. The MBB has also committed to providing long-term support in appealing for revisions to regional policy goals.

Building Industry Consultative Council (BICC)
The BICC committed to support one of the recommendations of this research (Section 7.3.2.2) by assisting in the formulation of 'Heritage Buildings: A Guidance Manual' and publishing it. The objective of this document will be twofold. It will increase awareness in the private sector regarding the energy performance potential of passive environmental design strategies in heritage buildings. Additionally, it will enable heritage building owners and occupants to identify and maximise passive environmental design strategies.

7.4.3.2 Invitations from Stakeholders

Following the launch of the research findings, the following invitations were received:

- Din L-Art Helwa (non-governmental organisation): Invitation from Perit Joanna Spiteri Stains (council member) to support Din L-Art Helwa in its endeavour to preserve and protect Malta's built heritage.

15 Perit: title of warranted architect and civil or structural engineer in Malta (Kamra tal-Periti, 2018b)

- University of Malta: Invitation from Prof Vincent Buhagair (Head, Department of Environmental Design) to present the research findings to students of the Faculty for the Built Environment.

7.4.4 Increasing Awareness

This research increased awareness, triggered interest and successfully disseminated information to stakeholders. The mechanisms used are described in this section, and include: events organised through this research, or as a result of interest emanating from this research; media outputs; and independent publications referencing this research.

7.4.4.1 Events

Events organised as part of this research are presented in Appendix F. These include a conference, seminar and presentation of research findings. Participants were receptive towards garnering further information on this subject. Anecdotal information received following the seminar demonstrated a willingness to balance the requirements of modern day living with the principles of passive environmental strategies in terms of comfort. One participant in particular amended the design of an on-going heritage building conversion project to incorporate the information transmitted through the event, and reflect the principles of sustainable regeneration of built heritage. These events also sparked interest in stakeholders, who subsequently organised additional events in collaboration with this research. These are also presented in Appendix F, and included study tours, technical presentations and public lectures.

7.4.4.2 Media Outputs

This research has received significant media attention including through national newspapers, bulletins and television programmes, as well as on local radio shows and through social media platforms. These outputs are described in detail in Appendix G. Through the local media, this research has successfully disseminated information on the sustainable regeneration of built heritage, facilitating an increased public awareness regarding the energy performance potential of this architectural typology.

7.4.4.3 Published References to the Research

This research was referenced in independent publications. These are listed in Appendix H, and include books, a report, a public consultation paper and a magazine.

7.5 Limitations

This research is limited to heritage buildings typical of the Mediterranean region. This architectural typology was designed to provide shelter and comfort in climatic conditions similar to that of the case study country, Malta, which is characterised by mild winters and hot summers (Buhagiar et al., 2017). Consequently, the passive environmental strategies explored through this study are primarily geared towards the passive cooling systems present in the architectural vernacular typical of this region, such as the courtyard and south-facing loggia. Assessment of factors impacting the energy performance of such buildings was limited to architectonic configuration and characteristics, occupant behaviour and passive environmental control measures. Active control mechanisms and renewable technologies were not considered.

Results are derived from a wider study addressing national aspects in Malta, and a case-specific study evaluating a particular heritage building. The wider study focuses specifically on the infrastructural framework for the sustainable regeneration of built heritage in Malta, and the systems that were being utilised by the country over the period of research (2015-2019). Heritage buildings are explored in more detail through the adopted case study of San Anton Palace, a mixed-use, highly populated building of significant historic, cultural and architectonic value (Soler, 2018).

7.6 Future Research

This research is an initial step towards the sustainable regeneration of heritage buildings in Malta. It has identified gaps in the body of knowledge on improving the environmental performance of heritage building, and the impact of occupant behaviour, which should be addressed through future research. However, building on the findings presented in this chapter, this section specifies immediate actions to be taken further to this study.

These focus on two primary areas: furthering the study and validating specific recommendations.

7.6.1 Furthering the Study

It is recommended that public perceptions and awareness levels are investigated further through a questionnaire targeting a wider population sample of the general public. This would generate statistically significant data based on which robust inferences can be made. The findings should enable the development of a tailored strategy to foster an environment which is more receptive to the sustainable regeneration of built heritage.

In enabling informed decision-making in the design of heritage building re-use and retrofit projects, the environmental performance potential of passive environmental design strategies should be investigated. Future research should explore the impact of individual characteristic features on the building's energy profile. Additionally, in order to develop a better understanding of the effect of changes to the architectural configuration or fabric, the relationship between passive environmental design strategies should also be examined. This should be complemented by an analysis of the benefits of traditional practices based on the hypothesis that these offer notable benefits to the environmental conditions of the building. Future research in this context should begin with a deep assessment of environmental data recorded at San Anton Palace through this study.

The San Anton Palace case study provided a preliminary review of the challenges faced in retrofitting heritage buildings having high cultural, architectonic and historic value. San Anton Palace was chosen specifically for its complexity, such that the resultant findings could be applicable to a wide spectrum of heritage buildings. Future research should develop the conclusions of this study and analyse tangible, technical solutions to improve the energy performance of smaller scale, single-use heritage buildings. Studies may incorporate strong links at a European level, through twinning research projects such as 3ENCULT, in order to tap into funding opportunities and information resources.

7.6.2 Validating Specific Recommendations

7.6.2.1 A Revised Regulatory Infrastructure

The shortfalls of the existing regulatory infrastructure, as outlined in Section 7.3.4.2, highlight a clear need for a revised system. It is being recommended that the framework is restructured to adopt an integrated approach to the assessment of heritage building proposals, as illustrated in **Error! Reference source not found.**. The process should be undertaken by all major stakeholders collaboratively, and managed by a coordinator, such as the proposed Building and Construction Regulator (Malta, 2018), to ensure an effective system.

The Chamber of Architects and Civil Engineers supports the consolidation of legislation and regulatory bodies within one umbrella (Kamra tal-Periti, 2019a). However, the infrastructure proposed through this research recognises the need for a solution when deliberation between the Planning Authority, Superintendence of Cultural Heritage and Building Regulations Office is unsuccessful. Therefore, it is being recommended that where agreement is not reached, the case is forwarded to a Conciliation Panel, functioning similarly to the Design Review Panel (Design Review, 2013), in that the proposal is reviewed by an independent group of experts. In this case, the panel's remit will extend beyond guidance, to the approval or rejection of the application. Based on the assumption that the cases faced by the panel will be challenging in nature, their decisions may be translated into standards and guidelines, and disseminated to stakeholders.

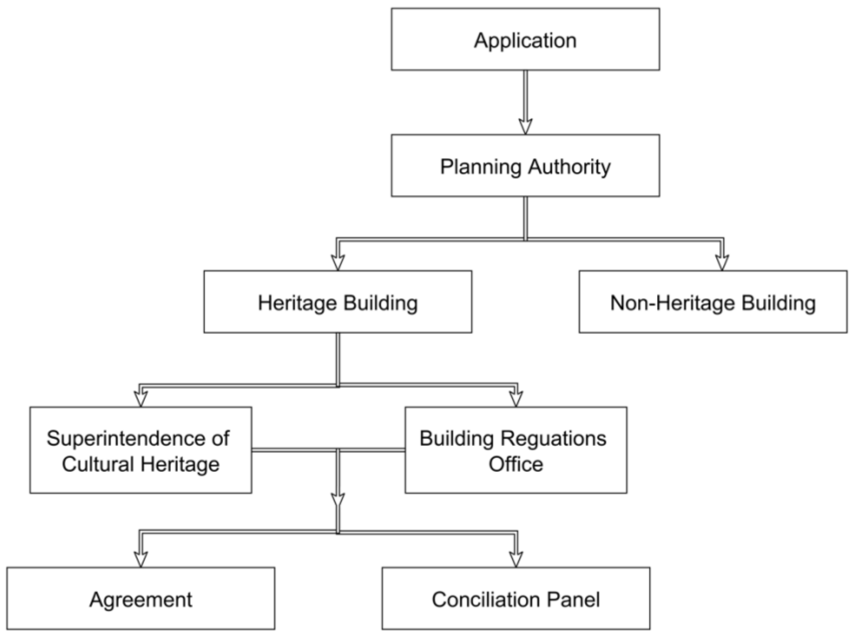

Figure 7.1: Proposed framework for the assessment of heritage building applications

If the proposed system (Figure *7.1*) is to be successful, the perit should be closely involved throughout the entire process, allowing for discussion and justification of design decisions. Additionally, each entity must have clearly defined roles and responsibilities. The Planning Authority's role will focus on development planning, as originally intended (Kamra tal-Periti, 2019a). Therefore, its responsibility will mainly relate to context, massing (building height and scale) and use. Currently, use is assessed against designated macro-scale land use plans, encompassing municipal sites. Condensing the planning officer's remit of assessment will enable a more detailed site analysis and customised appraisal of sensitive adaptive re-use in the case of heritage building interventions.

Once the Authority is satisfied, and having differentiated between heritage and non-heritage developments, only relevant applications will be forwarded to the Superintendence of Cultural Heritage and the Building Regulations Office to deliberate collaboratively. This approach will aim to find a common solution acceptable to all assessment officers, as advocated by Böttcher (2014b). To facilitate this, the entities will be bolstered by financial resources and trained staff. Although each shall have a different focus, retaining their respective remits in heritage conservation and energy performance, they should not function in isolation. Silo-based structures have been shown to impede the design, assessment and implementation process, and should, therefore, be avoided at all costs (Rivas et al., 2016). A structured procedural basis for a common integrated and coordinated assessment will enable a new openness throughout the deliberation process, allowing for the right values to be placed in the right sequence. This approach was recommended by the focus group, and is also endorsed by Böttcher (2014b):

> *"I would not try to turn Neuschwanstein Castle into a low-energy building. That would not be a meaningful approach. But for a large proportion of our old town buildings, there will always be a way to improve the energy efficiency".*

The proposed infrastructure plays an important role in cultivating an environment that shifts away from regarding heritage conservation and energy performance as unilateral concepts assessed independently and at a basic level. This entails a transition to a broad-minded approach, which moderates energy efficiency, environmental comfort and sensitive re-use, in a context compatible with the heritage value of the building. This is advocated by Böttcher (2014b), who argues that compatibility with heritage value may relate to anything from aesthetics to traditional building technology.

The relevance of adaptive re-use and occupant comfort has already been recognised by stakeholders, who accept that, in general, conservation entails compromise. However, these aspects are not fully understood, and their importance is not entirely appreciated, as demonstrated through the superficial nature of answers on existing and expected comfort levels in both workshops. This highlights a concerning lack of insight into user requirements and occupant comfort, particularly given the impact of user behaviour on energy use (Ouyang and Hokao, 2009; Ben and Steemers, 2014; Wilson et al., 2015) and the benefits of user comfort (Wagner et al., 2007; Klein et al., 2012; Yang et al., 2014; Zhao et al., 2015).

The existing context strengthens the argument for a case-by-case, performance-based approach to proposal design and assessment, as suggested by the participants of the stakeholders workshop and focus group. Research supported by the European Commission endorses this principle (Böttcher, 2014a). The restructured framework also calls for a new openness on the part of periti who, until now, tend to omit consideration of PEDS from their designs proposals. The literature encourages this shift internationally, recognising the need for periti to include eco-refurbishment in heritage building proposals (Böttcher, 2014b). Stakeholders agreed that heritage buildings were designed to maximise comfort. However, this is hardly possible unless the current framework is revised. This research contributes to outlining changes to effectively support the optimisation of PEDS to maximise end-user comfort.

The findings of the planning authority workshop highlighted the perit's role in developing interventions that do not impinge upon heritage or energy value. This is not necessarily in line with a moderated approach to eco-refurbishment. Moreover, in the absence of a guiding policy and evidence-based data, the perit is left with anecdotal information which, in the current market, is unlikely to convince the client. The correlation between use, occupant comfort, building performance and heritage value is not evident in the fragmented and sometimes incongruent standards and guidance available, thereby conditioning an environment of blanket assessment based on vague policies.

7.6.2.2 **Prototype Framework**

Many of the aspects highlighted through this research were found to overlap and link. In general, these would function more effectively when implemented within a structured holistic methodology. This is exemplified through a prototype framework illustrated using a number of case examples derived through this study, specifically:

- Case Example *6.6*: The Innovative Design Case;
- Case Example 6.3: The Case of the Maltese Timber Balcony;
- Case Example 6.4: The Case of the Photovoltaic Panels vs the Roof Gardens; and
- Case Example 6.5: The Craftsmanship Case

These cases amalgamate several key concepts, including: innovation and research; standards, training and craftsmanship; and financial incentives and auditing. Each case example is discussed below, and the missed opportunities are identified.

- **The Case Examples**

Case Example 6.6: The Innovative Design Case
Case: In order to satisfy the client's brief, a local perit re-thought the traditional timber balcony, a PEDS characteristic in Malta. By working closely with specialised craftsmen, the re-designed the balcony structure such that it could be completely opened up. In this way, he adjusted the PEDS to suit his client's lifestyle requirements, namely the provision of unobstructed views, whilst simultaneously retaining the heritage value of the element. This is a good step forward because, as a result, user expectations have been satisfied (provision of views) and comfort has increased (more natural light).
Missed opportunity: Means of adapting the PEDS to improve energy performance were not explored. In fact, environmental control has been reduced: the opening providing access to the balcony was widened and the door panels were removed, reducing the heat buffering effect that the balcony may deliver. Research could be used to further develop an innovative design, which equilibrates heritage value, energy performance and lifestyle expectations. This approach has been undertaken successfully elsewhere in Europe (3ENCULT, 2014).

Case Example 6.3.: The Case of the Maltese Timber Balcony
Case: The Planning Authority, in collaboration with government, launched a grant scheme to incentivise the restoration and maintenance of traditional timber balconies. The objective of the scheme was mainly focused on heritage conservation. The option to retrofit green initiatives was offered provided that the design remained compatible with the conservation status of the property, restricting the nature of the retrofit to replacement of glass panels with double-glazing. The use of non-traditional materials was not permitted, and the potential for innovative design not exploited.
Missed opportunity: This case indicates unclarity regarding the value of the traditional timber balcony within a historic context. Support was limited to works which retained the original

design, thereby omitting the possibility of altering the timber balcony to align with a modern lifestyle, and enable better environmental control and improved energy performance. The balcony was not addressed as a PEDS, but rather as a heritage feature in a forum of total preservation that is incompatible with innovation.

Case Example 6.4.: The Case of the Photovoltaic Panels vs the Roof Garden
Case: The Regulator for Energy and Water Services, supported by government, issued a grant scheme to subsidise the installation of photovoltaic panels, with the objective of promoting the use of renewable energy sources in Malta. The grant was not backed by evidence-based data outlining the expected cost and energy savings and no audited results were disseminated. In contrast, a proposed grant scheme subsidising the installation of green roofs was not taken up, despite academic research presenting the associated benefits.
Missed opportunity: This case demonstrates that high-level decisions are not always founded on evidenced data. The expected cost and energy savings resulting from the photovoltaic panel grant was not audited against those achieved. The initiative did not incentivise a reduction in energy use. Additionally, there was no take-up by government of a proposed national grant scheme supporting a validated passive design mechanism (roof gardens) to reduce energy demand and enhance the urban landscape. However, research exploring the potential of the roof garden did not explore the implications of incorporating this mechanism into the traditional structural configuration of heritage buildings.

Case Example 6.5.: The Craftsmanship Case
Case: Prior to issuing a grant scheme for the restoration and maintenance for heritage building facades, including timber elements, the Planning Authority undertook a process of assessment, training provision and setting standards in order to improve the quality of work in this context. Equipped with an understanding of the issues related to poor quality workmanship, the Authority familiarised itself with the obstacles faced by craftsman. The knowledge gained through this assessment was used to draft guidelines for carpenters and restorers. Funds were then secured to provide training, supporting craftsmen in obtaining qualifications to meet the specified standards. The standard was advertised through grant funded training, resulting in an improved quality of work.
Missed opportunity: The issues faced by the general public were not considered as part of the preliminary assessment. Had this aspect been factored into the information gathering phase, the Authority have factored in comfort and lifestyle expectations, and adopted a less rigid approach to the apertures and balcony aesthetic. Additionally, a registry of qualified craftsmen was not made available.

- **The Developed Prototype**

By holistically considering these cases, and by applying the audit cycle (Hexter, 2013), a process has been derived which may be applied to PEDS as a template for best practice. This is illustrated in (Figure *7.2*), which highlights the milestones of a SRBH strategy.

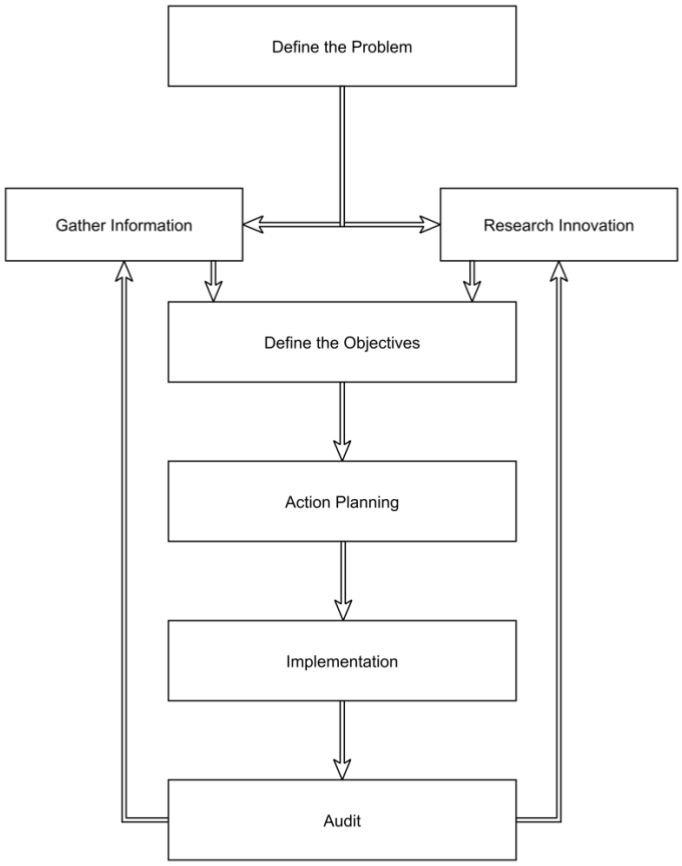

Figure 7.2: The prototype cycle developed through this research

The prototype cycle is implemented in this section, using the timber balcony as an example. The previously identified parameters such as standards, training and craftsmanship, financial incentives and audits, as well as innovation and research are applied to the framework.

Step 1: Defining the problem
At an urban scale, the traditional timber balcony is not being properly maintained. Restoration techniques are being lost, and the cost of maintenance is a burden on property owners. Apart from having heritage and cultural value, this feature is also a PEDS, however, its potential energy performance and ability to provide environmental control is not being maximised.

Step 2A: Gather information
All relevant stakeholders will be targeted during the preliminary assessment of the problem in order to benchmark context. The experience of owners/occupants will highlight the advantages/disadvantages of the timber balcony in terms of use, comfort and maintenance, as well as any other aspects which arise from the analysis. Craftsmen and periti will describe the practical obstacles they face in restoration and maintenance, as well as the difficulties in adapting the balcony to a modern lifestyle. Assessment officers will define the issues commonly arising in proposals for interventions, in the context of this element, and provide a measure for the standard of current practice. Gathering information should be complemented by research as necessary.

Step 2B: Research and Innovation
Research is necessary to inform policy and objectives by, for example, deriving estimated targets, and to support the audit process. Bolstered with the information gathered during the

preliminary assessment stage, research and innovation will be used to benchmark the energy performance of the traditional timber balcony, and explore sensitive solutions that maximise environmental control, whilst retaining the aesthetic. In this context, innovations will extend past existing lifestyle-focused solutions, to address environmental control and increase comfort.

Step 3: Define Objectives

Equipped with information derived from the preliminary assessment, objectives are defined in line with overarching policy goals. Once these are clear, measures to achieve the objectives and determinants of desired change are also defined. In the context of this problem, and in line with the principles of SRBH, the objectives are to conserve the heritage value of the Maltese landscape and reduce energy demand. The measures taken in meeting these objectives will centre on:

- The establishment of standards and provision of training programmes;
- Research and innovation to maximise the energy performance and environmental control provided by the timber balcony;
- Financial support for the provision of training and to incentive works; and
- Awareness campaigns and dissemination of information to influence behavioural change.

A variety of alternative measures will be explored and assessed before finalising the selection. The success of chosen measures will be determined by: the number of projects submitted for funding; the improved quality of workmanship achieved in these projects; a reduction of energy demand in households which benefited from the grant scheme; and a higher density of discussions on the subject across media platforms.

Step 4: Action Planning

The action planning phase will include: selection of target groups; assessment of instruments; and resources planning. In this context the target groups comprise homeowners of heritage buildings featuring a traditional timber balcony, and craftsmen. Instruments include training programmes to support qualification of craftsmen and fiscal measures to enable the feasibility of works on the traditional timber balcony. In order to select the most appropriate instrument, the potential of various tools will be explored: for example, grants, subsidies or tax rebate in the case of financial incentives. Resources to implement the process will be secured, or made available, at this stage. These include financial resources, materials (e.g. high-quality timber), and human resources (e.g.: training staff). Logistical issues, including organisation and management, will be finalised prior to implementation. Additionally, targets will be defined outlining the percentage of balconies to be maintained, restored or retrofitted, and the percentage of energy savings to be attained.

Step 5: Implementation

Prior to the official issuance of the financial measure supporting the maintenance, restoration and/or retrofit of the traditional timber balcony across Malta:

- Standards and guidelines, in line with the desired quality of work, will be drafted to establish criteria for best practice. A positive response to the standard will be encouraged by pairing it with fiscal measures to attain it, including funded training and grant schemes.
- Training will be provided so that craftsmen responsible to restore, maintain or adapt traditional timber balconies become qualified in line with the established standards and guidelines. The multi-faceted programme will include hands-on demonstrations

and field experience, and course content will be informed by the knowledge gained through preliminary assessment and research, as well as the standards and guidelines. A register of qualified craftsmen will be made available to the scheme operators, profession and general public.

- Officers responsible to assess the grant applications will be trained in line with the policy objectives.
- Awareness campaigns, including the use of mass media, will be used to promote the scheme and support positive environmental behaviours. Dissemination of information will be multi-faceted, targeting the price-based approach, the environmental approach and the social approach. It will focus on the value of the timber balcony as a heritage feature characteristic to Malta, and link its potential to reduce energy demand through positive environmental behaviours.

Step 6: Audit

The audit process will begin concurrently with the take-up of grants. It will monitor the results of the implemented measures, and evaluate the outcome according to the defined performance indicators. The results of the audit will be used to validate the grant scheme. If the targets are not met, the data will support research of measures to improve the result, and determine whether alternative solutions exist to further progress. The audit findings will be disseminated to the main actors in the field, including policy-makers and the profession. They will also be made publicly available in a transparent forum.

In this way, a strategy to address the defined problem is not unilaterally focused on heritage conservation but, rather, introduces a complementary aim: to maximise the energy performance and environmental control of the traditional timber balcony in line with modern lifestyle requirements. It shifts away from the concept of retaining all heritage buildings as they originally were in their totality. In contrast, it welcomes a balance between conserving the vernacular aesthetics, maximising energy performance and satisfying modern lifestyle expectations dependent on the building use.

The framework is formulated to encompass the setting of standards, attained through training and incentives, as well as mechanisms for research, innovation and auditing to maximise potential and validate results. It enables the use of innovative techniques to maximise, for instance, natural lighting, as well as the sensitive use of contemporary materials, whilst simultaneously reducing maintenance costs. This is not necessarily applicable in all contexts. It may not be acceptable or necessary for example, to retrofit timber balcony at San Anton Palace. When these are in some way conflicting, the framework allows for an element of compromise depending on the circumstance.

7.6.2.3 The Sustainable Regeneration of Built Heritage Platform

In order for the prototype described in Section (7.6.2.2) to function effectively, and drive the SRBH, the elements recommended through this research cannot exist in isolation. A coordinating body is necessary to ensure that all measures are woven together harmoniously towards a common goal, and implemented effectively through collaborative effort between all entities. In this context, a SRBH Platform is being proposed as a multi-faceted tool to provide direction towards specific aims and objectives. The platform emerges from this research as a tool for the establishment of a stakeholders network, including built environment professionals, academics, students, policy-makers and non-governmental organisations, and enabling effective and structured knowledge transfer and sharing between the various stakeholders, both locally and internationally.

It should function as a driver for the SRBH, both in the domestic and the private sector. To this end, there should be a loose relationship between the SRBH platform, and the primary bodies and actors in the field, including: educational institutions; the Planning Authority; the Superintendence of Cultural Heritage; the Building Regulations Office; the Chamber of Architects and Civil Engineers; and non-governmental organisations. For instance, there should be coordination with educational institutions to identify gaps in the knowledge base, and share knowledge gained from research across interested parties. Having established these relationships, the platform should act as a mechanism for:

- Synchronising and disseminating the findings of future research;
- Supporting the formulation of standards and guidelines for the eco-refurbishment of heritage buildings, and making these available to all stakeholders, including the public, the profession and the assessment bodies;
- Collating good practice examples in an online repository that is easily accessible;
- Making recommendations on the provision of continuing professional development and training programmes; and
- Keeping a register of qualified persons in the field, including craftsmen.

It should be a point of reference, for a number of stakeholders including, for instance, journalists with a desk for heritage or the environment, who wish to bolster their knowledge base before reporting on a related subject. Participants of the stakeholders workshop highlighted that journalists are not knowledgeable on the subject of SRBH and PEDS and that, consequently, they are restricted in their ability to transmit and disseminate information effectively to the public. The platform would therefore be valuable in facilitating more effective reporting on the subject in general.

The SRBH platform should inherently function as an instrument for increasing public awareness. By accommodating and integrating the different perspectives of interested parties, the platform should support those entities in generating a better understanding of common challenges and innovative solutions. Subsequently, it should ensure high visibility, accessibility and promotion of pertinent issues. In this context, it should run well-coordinated information campaigns, facilitating widespread dissemination to the selected target audience at appropriate times, particularly at key milestones, and using appropriate mechanisms.

In doing so, one or more specific target groups will be identified, including: the professional sector; the private sector (occupants, owners, developers); the general public; non-governmental organisations; policy-makers; and public bodies. Methods for information delivery will be designed specifically for the selected target audience. The platform website will, for instance, be a primary data source for the professional and private sector: the profession will be linked to scientific research, whereas a frequently asked questions section and the recommended home-owners guide will be accessible to the private sector. Further outreach to the public and non-governmental organisations will be achieved through social media, permitting bi-directional communication, and mass media allowing additional avenues for promotion. The platform should also actively participate in external events, including seminars and talks, organised in-house or through different entities.

The platform should also coordinate specific projects in an effort to develop case-based examples through trans-disciplinary research. In this context, links with existing initiatives, such as 3ENCULT, should be established to tap into sources of rich information and funding. It is recommended that the preliminary findings of the research on San Anton Palace be further developed, in line with Article 5 of European Directive 2010/31/EU, which highlights the exemplary role that should be adopted by public bodies through their buildings (Derjanecz, 2015). Ideally, the study should be carried forward to qualify as Malta's project for 3ENCULT, or similar initiatives.

7.7 Concluding Remarks

This chapter has discussed and presented the key findings of this research (Sections 7.2 and 7.3).

Further to Research Aim 1, the key findings of the case-specific study demonstrate that the inherent potential of PEDS at SnAP is not being fulfilled. Aspects impacting the maximisation of PEDS have been identified: these are user-centric and mainly focused around occupant decisions and behaviours.

The findings of the architectonic assessment (Objective 1A) and the occupant survey (Objective 1B) are summarised below:

- In the absence of a long-term strategy, the room use designation and restoration of SnAP is dependent on the objectives of each presidential term; and
- Occupants unconsciously resort to the use of PEDS to improve comfort conditions, however, in some cases the maximisation of PEDS was impeded.

The findings of the environmental monitoring of in-use heritage buildings (Objective 1C) demonstrate that user-related barriers may be mitigated by:

- Engaging building occupants;
- Limiting inconvenience and intrusion; and
- Taking action to avoid interference.

Further to Research Aim 2, the key findings of the wider study demonstrate that the sensitive, sustainable and adaptive re-use of heritage buildings in Malta is not adequately supported or facilitated. Four main user groups were identified as impacting the sustainable regeneration of built heritage, namely:

- Public & Occupants / Users of heritage buildings;
- Professionals and craftsmen intervening on heritage buildings;
- Academia; and
- Legislators, policy-makers and regulators

The findings of the wider study demonstrate that:

- Cost implications, perceived lack of comfort and difficulties associated with a heritage building project all deterents to sustainable regeneration of built heritage in Malta. Dissemination of information, as well as fiscal incentives, are key tools in improving public awareness and attitudes, and influencing behaviour change in this user-group (Objective 2A);
- In general, concepts of sustainability and heritage are yet to be effectively amalgamated in educational programmes, and the training framework has yet to be bolstered with continued professional development and specialised courses in this field. The lack of a robust knowledge sharing and training platform, and a systematic

research and innovation infrastructure, is a barrier to further understanding the impacts of passive environmental design strategies (Objective 2B); and

- Environmental performance and heritage conservation are addressed as completely distinct subjects in legislation and policy, and are assessed as such, if at all, throughout regulatory processes. Existing standards and guidelines manifest incongruities when applied to heritage buildings. Recent initiatives have resulted in the establishment of examples of good practice (Objective 2C).

As part of this research, measures to address the above-listed issues have been explored. These comprise quick wins and long-term solutions. A summary of the recommendations is presented in the Section 7.4.1. The limitations of the study, as well as opportunities for future research, are also outlined in Sections 7.5 and 7.6 respectively.

The conclusions derived through the findings of the case-specific study and wider study are presented in the next and final chapter.

Chapter: 8 Conclusions

8.1 Introduction

This research sought to explore areas of priority in the sustainable regeneration of built heritage in Malta, taking into consideration the passive environmental design strategies characteristic of the vernacular architectural typology. Exploiting the potential of passive environmental design strategies improves comfort provision and environmental performance, and is conducive to heritage conservation, thereby responding to international concerns and safeguarding inherent building features. The lessons learnt through this study are applicable to other Mediterranean countries with similar climatic conditions and architectural typologies.

The context of this research addresses a vernacular architectonic style and cultural setting on which few qualitative studies have focused. The study has addressed gaps in the evolving body of knowledge on the eco-refurbishment of heritage buildings. There is general consensus regarding the need to achieve equilibrium between heritage conservation and energy performance; a balance endorsed through this research. However, few studies incorporate the third important criterion of occupant behaviour in traditional buildings, despite its potential to reduce energy demand. This gap has been highlighted in current literature. User interaction with the building is even more critical when there is a change of use, as illustrated through the adopted case study of San Anton Palace. Whereas the recently published CEN standard (EN16883: 2017) provides welcome and much needed guidance, there is no clearly defined and widely accepted methodology that incorporates architectonic survey, user involvement, environmental performance assessment and other relevant aspects. These components were integrated in the San Anton Palace case study, to generate a user-centred methodology for the selection, implementation and monitoring of solutions to improve heritage building comfort and energy performance.

8.2 Fulfilling the Objectives

This research supports the hypothesis that, in the absence of a dedicated framework and forward planning strategy supporting the sustainable regeneration of built heritage in Malta, the potential offered by passive environmental design strategies to improve occupant comfort in heritage buildings, is being compromised.

Optimising passive environmental design strategies to improve the building's environmental performance enables a reduction in waste and energy demand. Although this may not compare to the results achieved in a near zero energy building, the collective contribution of heritage buildings will still have a positive impact on national energy savings. It will also support the conservation of cultural and heritage value.

Research Aim 1: This study has concluded that the inherent potential offered by passive environmental design strategies at San Anton Palace is being compromised. The research objectives associated with this aim have been fulfilled as described below.

Objective 1A_ Assess the architectonic characteristics of San Anton Palace, and whether past interventions on the building fabric impact occupant comfort and environmental performance: The architectural configuration, characteristic features and building fabric and finishes identified at San Anton Palace are conducive to a design that considers occupant comfort and environmental performance. However, this research identified examples of new uses, lack of maintenance and past interventions which may negatively affect the fabric and performance of the palace. The findings also highlight that traditional practices intended to improve occupant comfort by providing environmental control, are no longer adopted. These and other factors contribute to a high dependency on active control mechanisms and, consequently, greater energy demand.

Objective 1B_ Evaluate the attitudes, perceptions of comfort and functionality, and environmental behaviour of occupants at San Anton Palace: This research highlighted a general lack of comfort and functionality at San Anton Palace as perceived by users, primarily administrative staff. This was mainly resultant from an inability to interact optimally with the building as a consequence of interior design layout, fittings and furnishings, all of which have an impact on occupant behaviour. Consequently, certain passive environmental design strategies were found to be under-utilised, especially louvred apertures, resulting in a high dependency on active environmental control mechanisms, possibly also associated with learnt behaviour. Where it was feasible to do so, users did exploit the environmental conditions offered by passive strategies, such as the loggia. The occupants' attitude highlighted an appreciation of the building's heritage value, and an associated willingness to compromise on comfort. This study contributed to the knowledge gap on the effect of interior design layout, fittings and furnishings in heritage buildings on users' attitudes, perceptions and behaviour, and highlights the importance of engaging and integrating occupants in a retrofit project.

Objective 1C_ Identify user-related barriers to environmental monitoring in heritage buildings: The value of environmental sensing is widely acknowledged. However, this research identified specific challenges presented by the process of in-use monitoring of mixed-use buildings. The field of user interaction and interference with data loggers, has not been sufficiently explored in the literature. This study highlighted the importance of identifying different user profiles, given that each respond differently to the process, and the value of engaging building occupants who generally experience sensors in a passive way. The study emphasised that information dissemination should go beyond awareness to promote ownership of the environmental monitoring and retrofit project.

Research Aim 2: Having examined areas of priority in the sustainable regeneration of built heritage in Malta this research has concluded that the sensitive, adaptive re-use of historic architecture is not supported by an effective infrastructure. The research objectives associated with this aim have been fulfilled as follows:

Objective 2A_ Evaluate the public's perceptions of the sustainable regeneration of heritage buildings and heritage buildings in Malta, and the level of awareness regarding the applications of passive environmental design strategies: A questionnaire was used to establish the perceptions and level of awareness of a group of public respondents. Two workshops and a focus group were used to develop an understanding of the stakeholders' experiences and opinions of public attitude and behaviour towards the sustainable regeneration of built heritage, heritage buildings and passive environmental design strategies. The findings indicate that the public has a positive attitude towards conservation but does not regard heritage buildings as feasible dwellings that meet modern expectations, and provide comfort and functionality. A transitional-gap was identified whereby respondents were not able to associate the functionality of passive environmental design strategies with the application of these features in heritage buildings. This research highlights the importance of increased awareness of the role of heritage buildings and energy behaviour in sustainability, particularly through the effective use of passive environmental design strategies. However, it acknowledges that this does not necessary actuate behavioural change, but rather fosters an environment that is conducive towards influencing change. The study, therefore, emphasises the value of customising dissemination of information towards promoting tangible cost benefits, environmental benefits and social benefits, and of coupling this with incentives to which the public has responded well in the past.

Objective 2B_ Appraise the knowledge base, and level of awareness of stakeholders involved in designing and assessing interventions on heritage buildings: In general, stakeholders were found to have a low level of awareness on improving energy performance of heritage buildings. The results highlight a need to improve the knowledge base and address knowledge gaps in this field. This research proposes revisions to the educational system of professionals, and the provision of targeted training for other key stakeholders, including assessment officers. It highlights areas were research and innovation are required, and proposes mechanisms for knowledge transfer and sharing. This should enable evidence-based, energy-conscious decision-making that considers use and heritage conservation, and incorporates passive environmental design strategies in the design of sustainable retrofits.

Objective 2C_ Determine whether the existing regulatory framework targets and supports all relevant parameters in the design and assessment of heritage building interventions: The existing regulatory framework targets heritage conservation but does not effectively consider energy performance or sensitive adaptive re-use in interventions on heritage buildings. The legislative and regulatory infrastructure, as well as standards and design guidelines, do not specifically address or provide direction for eco-refurbishment. This research proposes an alternative approach that supports the interdisciplinary team in developing design proposals, as well as the assessment officers in balancing heritage conservation, energy performance and adaptive re-use through dialogue.

8.3 Conclusions

The conclusions of the case-specific study are summarised below:

1. Further to Research Aim 1, this research has demonstrated that the inherent potential of passive environmental design strategies at San Anton Palace is not being maximised.
2. Further to Objectives 1A and 1B, this research has shown that past interventions implemented across several decades, and even centuries, have impacted on the comfort conditions of the building, consequently impacting occupant behaviour. A long-term strategy for the holistic use designation and systematic restoration, developed by a cross-disciplinary team and based on a continuously evolving architectonic survey, is required.
3. Further to Objective 1C, the user-related barriers to environmental monitoring of in-use heritage buildings have been identified. The literature has highlighted the challenges of environmental monitoring (Guerra-Santin and Tweed, 2015). However, this research has identified gaps in the knowledge base relating to the impact of occupants on the monitoring exercise. The best practice guidelines developed and validated through this study have demonstrated the benefits of a user-centred approach to monitoring the environmental parameters of an in-use building.

The conclusions of the wider study are summarised below:

1. Further to Research Aim 2, this research has demonstrated that the sensitive, sustainable and adaptive re-use of heritage buildings in Malta is not adequately supported or facilitated.

2. Further to Objectives 2A and 2B, the respondents' perceptions, and stakeholders' knowledge base are areas of priority in the sustainable regeneration of built heritage. A holistic strategy to address both aspects should focus on supporting positive behavioural change and facilitating informed decision-making.
3. Further to Objective 2C, this research has shown that the existing regulatory framework does not adequately target or support all relevant paraments in the design and assessment of heritage building interventions. There are shortfalls in the legislative, policy and regulatory infrastructure, which do not enable sensitive and sustainable intervention. The system is not bolstered by effective standards and guidelines. Recommendations have been proposed, to be validated through future work, in order to address the issues outlined.

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Appendix A: Occupant Survey_ Interview Schedule

SECTION A: BACKGROUND

Question 1. Describe your role and responsibilities in San Anton Palace.

Question 2. How long have you been employed at San Anton Palace?

Question 3. Have you experienced any major changes to the structure and/or layout of the building? If so, why was this change carried out?

Question 4. Which room/s do you use regularly?

SECTION B: COMFORT

Question 5. For each room:

a) How much time do you spend in this room per day?

1 – 2 hours
2 – 4 hours
4 – 8 hours
> 8 hours

b) What type of tasks would you normally be carrying out here?

c) What is this room usually used for?

d) On average, how often do you enter/leave the room every day?

0 – 2 times
3 – 5 times
5 – 8 times
> 8 times

e) Are you ever alone in the room? At times when you are not alone:

How many people usually work in the room with you?
Do they generally carry out the same tasks as you?

f) Think about how you feel in this room at the moment. Are too hot or too cold? Is it dark or stuffy? Is there enough light?

Giving examples, rate on a scale of 1-5, 1 being very uncomfortable and 5 being very comfortable, how you feel in this room today?

Extremely uncomfortable
Uncomfortable
Neither uncomfortable nor comfortable
Comfortable
Extremely comfortable

SECTION C: INTERIOR DESIGN

Question 6. Internal Layout: For each room:

a) Is the design (**layout**) of the room/s appropriate for its function?

If 'yes', why does it work so well?
If 'no', why not? What would change about the room's **layout** to improve its functionality?

b) Does the design (**layout**) of the room maximise user comfort?

If 'yes', how? If 'no ', what would change about the room's **layout** to make you more comfortable?

Question 7: Furnishings: For each room:

a) Are the **furnishings** in the room fit for purpose?

If 'yes', why do they work so well? If 'no', why not? What would you change?

b) Do you ever move the current **furnishings** to make the room more functional?

If 'yes', what do you do? If 'no', why not?

c) Do you ever move the **furnishings** to make you more comfortable?

If 'yes', what do you do? If 'no', why not?

Question 8: Doors & Window Treatments: For each room:

a) Do you open/close windows/doors to make yourself more comfortable?

If 'yes' what do you do? If 'no', how do you make you more comfortable?

b) Do you open/close the window and door blinds/curtains to improve functionality (natural light levels) in the room?

If 'yes' what do you do? If 'no', why not? Do you do anything else?

c) Do you open/close the window and door blinds/curtains to make yourself more comfortable in the room?

If 'yes' what do you do? If 'no', why not? Do you do anything else?

SECTION D: GENERAL

Question 9. Think about your level of comfort here if you had to eliminate the use of artificial cooling, heating, lighting etc. Giving examples, rate on a scale of 1-5, 1 being very uncomfortable and 5 being very comfortable, how comfortable you find San Anton Palace to work/live in?
Extremely uncomfortable
Uncomfortable
Neither uncomfortable nor comfortable
Comfortable
Extremely comfortable

Question 10. What (if any) changes would you propose to improve the ease of using the palace?

Question 11. Are there any further comments/suggestions you wish to make?

Appendix B: Semi-Structured Interview with President Emeritus, Dr Marie-Louise Coleiro Preca_ Interview Schedule

SECTION A: FUNCTIONALITY AND COMFORT AT SAN ANTON PALACE

Question 1A. When you first came to San Anton Palace at the beginning of your Presidency, what were your initial impressions of the building?
NOTE: to focus on functionality and comfort in regularly used rooms.

Question 1B. In terms of comfort, you expected that the building would be cold in winter?

Question 1C. So that is your experience of your bedroom… What about your office?

Question 1D. Your Excellency, how did you identify the interventions you are discussing?

Question 2A. Which room/s do you use regularly, and for what?

Question 2B. And where is the office?

SECTION B: EXPERIENCE OF THE PALACE

Question 3. Are the uses of the Palace appropriate to building?

Question 4. Does the Palace maximise user comfort?

Question 5. As a primary resident, how would you rate comfort at San Anton Palace on this scale? NOTE: Present Likert Scale.

SECTION C: MODIFICATIONS TO THE PALACE

Question 6. What changes to the structure and/or layout of the building were made during your Presidency, and why?

SECTION D: OTHER

Question 7A. You clearly have a great deal of knowledge of this particular topic. Do you feel that you came on board with this level of knowledge?

Note:
New questions that arose during the semi-structured interview are noted in italics.

Appendix C: Public Survey_ Questionnaire Schedule

PART A: THIS SECTION IS TO BE FILLED IN **BEFORE** THE SEMINAR

1. Are you?

- Female
- Male
- Other
- Prefer not to say

2. How old are you?

- < 25
- 25-44
- 45-64
- 65+

3. What is your highest education level?

- Secondary Education
- Tertiary Education

4. Do you or have you lived/worked in a heritage building? Yes / No

5. Would you rather live in a heritage building or a contemporary building, and why?

____

____

6. What is your opinion of the current state of conservation and regeneration of heritage buildings in Malta?

____

____

7. List three main problems that are commonly associated with heritage buildings.

____

____

8. Rank, in order of importance, the goals you would set when undertaking a heritage building project, numbering them from 1 to 7, 1 being the most important.

- extending indoor area _______
- achieving user comfort via active systems (e.g. AC units) _______
- having sufficient natural light & ventilation _______
- conserving heritage features _______
- achieving user comfort by maximising building features _______
- achieving a stylish finish _______
- reducing energy demand _______

9. Rank in order of difficulty the main obstacles associated with undertaking a heritage building project, numbering the items from 1 to 9, 1 being the greatest obstacle.

- addressing humidity _______
- ensuring sufficient natural light _______
- addressing draughts _______
- insulating the roof _______
- ensuring that the building achieves modern standards of living _______
- insulating the external walls _______
- ensuring sufficient natural ventilation _______
- dealing with the Planning Authority _______
- making the building beautiful _______

10. Would any of the problems/obstacles listed in questions 7 & 9 discourage you from living in a heritage building? Yes / No

11. If you have been involved, as an owner or otherwise, in a heritage building project, do you feel that enough information and guidance was available? Yes / No

If no, where was this information lacking?

____

12. Do you think that energy demand is inherently greater in heritage buildings than it is in contemporary buildings? Yes / No

Why?:____

13. List two means of improving the energy efficiency of a contemporary building.

____

____

14. List two means of improving the energy efficiency of a heritage building.

____

____

15. Briefly describe the expected result of the following changes.

- Reducing wall thickness:____
- Roofing the internal courtyard:____
- Removing louvred shutters:____
- Retaining the traditional *deffun* roof structure:____________________________
- Applying a white membrane over the roof:_______________________________
- Increasing the size/amount of glazed area:_______________________________
- Using parquet as a flooring finish instead of traditional cement tiles:

____

16. In your opinion, which of the following affect energy efficiency of a heritage building?

- Thick walls with insulated cavities_ _ _ _ _ Yes No
- Internal courtyard_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Yes No
- Loggia_ Yes No
- Well located aperture_ _ _ _ _ _ _ _ _ _ _ _ _ Yes No
- Louvered windows _ _ _ _ _ _ _ _ _ _ _ _ _ _ Yes No
- *Deffun* roofing _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Yes No
- Limited areas of glazing _ _ _ _ _ _ _ _ _ _ _ Yes No
- Traditional cement tiles _ _ _ _ _ _ _ _ _ _ _ Yes No
- Other (please specify): ____

17. In your opinion, is there enough information and guidance available for persons wishing to improve the energy efficiency of a heritage building? Yes / No

PART B: THIS SECTION IS TO BE FILLED IN **AFTER** THE SEMINAR

1. Would you rather live in a heritage (H) or a contemporary (C) building? H / C

2. Rank, in order of importance, the goals you would set when undertaking a heritage building project, numbering them from 1 to 7, 1 being the most important.

- extending indoor area ______
- achieving user comfort via active systems (e.g. AC units) ______
- having sufficient natural light & ventilation ______
- conserving heritage features ______
- achieving user comfort by maximising building features ______
- achieving a stylish finish ______
- reducing energy demand ______

3. Do you think that energy demand is inherently greater in heritage buildings than it is in contemporary buildings? Yes / No

Why? ____

4. List two means of improving the energy efficiency of a heritage building.

____

____

5. Briefly describe the expected result of the following changes.

- Reducing wall thickness:____
- Roofing the internal courtyard:___________________________________
- Removing louvred shutters:______________________________________
- Retaining the traditional *deffun* roof structure:___________________________
- Applying a white membrane over the roof:___________________________
- Increasing the size/amount of glazed area:___________________________
- Using parquet as a flooring finish instead of traditional cement tiles:

____

6. In your opinion, which of the following affect energy efficiency of a heritage building?

- Thick walls with insulated cavities_ _ _ _ _ Yes No
- Internal courtyard_ _ _ _ _ _ _ _ _ _ _ _ _ _ Yes No
- Loggia_ Yes No
- Well located aperture_ _ _ _ _ _ _ _ _ _ _ _ _ Yes No
- Louvered windows _ _ _ _ _ _ _ _ _ _ _ _ _ _ Yes No
- *Deffun* roofing _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Yes No
- Limited areas of glazing _ _ _ _ _ _ _ _ _ _ _ Yes No
- Traditional cement tiles _ _ _ _ _ _ _ _ _ _ Yes No
- Other (please specify): ____

7. Are there any comments you wish to make?

____

____

Thank you for your participation.

Appendix D: Focus Group_ Schedule of Questions / Topics

SECTION A: ENERY POLICY AND LEGISLATION

Topics:
- Existing policy and legislation; and
- Roles and responsibilities.

Question 1A. Are you aware of the formal warnings from the European Commission to Malta, and other Member States?

Question 1B. What is the Chamber's [referencing Chamber of Architects and Civil Engineers] reaction to this?

Question 2. Do you agree that the Energy Performance Certificate (EPC) is the only formal document available locally touching on the area of energy performance?

Question 3. Is the Legal Notice [LN 47/2018] currently being enforced?

Discussion on:

- *responsibility of enforcement; and*
- *knowledge base to undertake legal responsibilities and awareness thereof.*

Question 4. Should the EPC be restricted to a transfer of property or should this be incorporated in any phase of redesign?

Discussion on:

- *appropriate procedures.*

Question 5. The Planning Authority (PA) are implying that periti are objecting to the requirement of EPC at design stage. What are your thoughts on this?

Question 6A. Do you agree that the Building Regulations Office (BRO) currently has the legal remit for EPCs?

Question 6B. Should this legal remit be retained by the BRO?

Question 6C. What are your thoughts on the PA being open to taking it on?

Discussion on:

- *ability to carry out the legal responsibilities.*

Question 7. Would you consider it a solution for all entities, with different remits, to come under one ministry, with enforcement taken on board as an overall perspective?

Note:
New questions / discussion topics that arose during the focus group are noted in italics.

SECTION B: OCCUPANT COMFORT IN HERITAGE BUILDINGS

Topics:
- Awareness and understanding across the profession / the market;
- Education and training
- Research and innovation

Question 1. How would you measure the cultural value and aesthetics of a heritage buildings against occupant comfort, the requirements that come with that, and the implications of occupant behaviour on energy performance?

Question 2A. In your opinion, are periti able to recognise passive environmental design features, and appreciate their value in terms of energy performance?

Question 2B. Does this knowledge enable periti to guide and advise their client in practical terms?

Present Case Example 4.1.: The Courtyard Case

Discussion on:

- *training the regulators vs removing their remit;*
- *existing training programmes for regulators.*

Question 3. Throughout this research, people/bodies/entities have frequently pointed to the lack of education and noted that periti should be more knowledgeable and proactive on the subject of environmental performance of heritage buildings. For example: propose means of improving the occupant. Do you agree?

Discussion on:

- *existing issues in the educational system;*
- *attitudes towards interventions on built heritage & understanding of conversation principles;*
- *ability to bring together the concepts of built heritage and energy conservation;*
- *market understanding and acceptance of heritage and energy conservation principles; and*
- *case example presented by participant (Case Example 6.1. The Hotel Conversion Case).*

Question 4. Is research into the passive strategies inherent in Maltese vernacular architecture yielding results that we can disseminate to the profession, enabling them to be more specific? For example: what are the consequences of removing wall thickness? Or how does the deffun roofing system perform when compared to contemporary solutions?

Discussion on:

- *UM taking this up.*

Note:
New questions / discussion topics that arose during the focus group are noted in italics.

Appendix E: Publications

Appendix F: Events

Events organised as part of this research	
Title	Sustainable Regeneration of Built Heritage Conference
Date/Venue	19 September 2016, San Anton Palace
Attendees	Policy-makers, regulators, operators; professionals; academia; NGOs.
Title	Sustainable Regeneration of Built Heritage: Public Seminar
Date/Venue	4 April 2018, San Anton Palace
Attendees	Self-selecting sample of members of the public.
Title	Sustainable Regeneration of Built Heritage: Planning Authority Seminar
Date/Venue	5 June 2018, San Anton Palace
Attendees	Representatives of various departments within the Planning Authority.
Title	Presentation of Research Findings
Date/Venue	28 January 2019, San Anton Palace
Attendees	Policy-makers, regulators operators; professionals; academia; NGOs; the public.

Events resulting from interest sparked through this research	
Title	Study Tour for Periti
Date/Venue	2 March 2019, San Anton Palace
Attendees	Council members of the Chamber of Architects and Civil Engineers (N=12)
Title	Study Tour for the Public
Date Venue	16 March 2019 (x3 groups) & 23 March 2019 (x2 groups), San Anton Palace
Attendees	Members of non-governmental organisation Flimkiek Ghal Ambjent Ahjar (N=100)
Link	https://timesofmalta.com/articles/view/private-tours-of-san-anton-palace.704615
Title	Technical Presentation: Malta Business Bureau (MBB)
Date/Venue	6 February 2019, Chamber of Commerce
Attendees	Council members of the Chamber of Architects and Civil Engineers (N=12)
Title	Technical Presentation: Building Industry Consultative Council (BICC)
Date/Venue	6 February 2019, BICC
Attendees	Council members of the Chamber of Architects and Civil Engineers (N=12)
Title	Public Lecture: hosted by Flimkiek Ghal Ambjent Ahjar (NGO)
Date/Venue	15 May 2019, Hotel Phoenicia
Link	http://josannecassar.com/environment/lecture-by-perit-amber-wismayer-sustainable-regeneration-of-san-anton-palace%EF%BB%BF/
Title	Public Lecture: hosted by APS Bank (Date/Time: TBC)

Appendix G: Media Outputs

	Newspaper Articles
Title	Project seeks to see how San Anton Palace can be made more energy efficient
Details	The Malta Independent / 19 September 2016
Title	Maximising the performance of heritage buildings
Details	The Malta Independent / 7 April 2018 pp.3
Title	Promoting green energy in heritage buildings
Details	Times of Malta / 7 April 2018 pp.6
Title	A strong commitment to protect cultural heritage is our duty for future generations - President
Details	The Malta Independent / 29 January 2019 pp.1&6
	News Bulletins
Programme	TVM News
Details	Public Broadcasting Services / 19 September 2016
Programme	TVM News
Details	Public Broadcasting Services / 6 April 2018
Programme	TVM News
Details	Public Broadcasting Services / 29 January 2019
	Television Interviews
Programme	TVAM / Antonella Vassallo
Details	TVM, Public Broadcasting Station / 11 April 2018
Programme	NET TV / Fabian Demicoli and Roberta Bonnici Felice
Details	NET / 29 January 2019
Programme	ONE TV / Wayne Sammut and Elaine Degiorgio
Details	One / 31 January 2019
Programme	TVAM / Quinton Scerri and Clara Farrugia
Details	TVM, Public Broadcasting Station / 1 February 2019
Programme	TVAM Weekend / Antonella Vassallo
Details	TVM, Public Broadcasting Station / 2 February 2019

Radio Interviews	
Station	Radio Malta 93.7 FM, Public Service Broadcaster / Interviewed by Joe Dimech
Aired	11 April 2018
Station	The Big Drive Home, XFM 100.2 / Interviewed by Trudy Kerr
Aired	24 January 2019
Station	Radio Malta 93.7 FM, Public Service Broadcaster / Interviewed by Joe Dimech
Aired	12 February 2019

Online and Social Platforms	
Author	Chamber of Architects and Civil Engineers
Links	https://kamratalperiti.org/event/sustainable-regeneration-of-built-heritage/?fbclid=IwAR0qs0-ibIW-BuTBVcF44wslcnEDMrMHHrUU6XM-HWUX4Pq5GT0OFRlUiWs https://www.facebook.com/KamraTalPeriti/posts/2521285851275584
Author	Marie-Louise Coleiro Preca, President of Malta
Links	https://www.facebook.com/watch/?v=2207915606126871 https://www.facebook.com/watch/?v=333440697275180
Author	TVM
Links	https://www.tvm.com.mt/en/news/san-anton-palace-to-serve-as-guide-on-how-antique-buildings-can-be-energy-efficient/
Author	NET News
Links	https://netnews.com.mt/2019/01/28/pjataforma-ghal-harsien-mir-rigenerazzjoni-sostenibbli-tal-wirt-mibni/?fbclid=IwAR3htPrMPNgB9qvgIe_9N3vxBdJBdSomH0HCvc6WkjeM75oF9iaamhUgZRY
Author	Malta Independent
Links	http://www.independent.com.mt/articles/2016-09-19/local-news/Project-at-San-Anton-Palace-seeks-to-make-it-more-energy-efficient-6736163959
Author	News Malta
Links	https://www.newsmalta.com/2019/01/29/a-strong-commitment-to-protect-cultural-heritage-is-our-duty-for-future-generations-president/
Author	Office of the President, press release
Links	https://president.gov.mt/press-centre-statement/sustainable-regeneration-built-heritage-workshop-held-today-san-anton-palace-auspices-president-malta/ https://www.marielouisecoleiropreca.com/press-centre-statement/historical-cultural-identity-san-anton-palace-special-place-history-islands/

Appendix H: Publications Referencing this Research

Publications Referencing this Research

Title	San Anton Palace 360°
Publication	Book
Author	Perit William Soler
Ref. Details	Soler, W., 2018. *San Anton Palace 360°*. Sliema: Miranda Publishers.
Title	Riflessjonijiet tal-President (Reflections by the President)
Publication	Book
Author	H.E. Marie-Louise Coleiro Preca
Ref. Details	Coleiro Preca, M.L., 2019. *Riflessjonijiet tal-President*. Birkirkara: Kite Publishing.
Title	Sustainable Communities: Housing for tomorrow
Publication	Report
Author	Dr Rachel Caruana
Ref. Details	Scicluna, R., 2019. *Sustainable communities: Housing for tomorrow*. Valletta: Parliamentary Secretariat for Social Accommodation. Available online: https://housingauthority.gov.mt/en/Documents/Schemes/Booklet.pdf
Title	A President's Legacy: Interview with H.E. Marie-Louise Coleiro Preca
Publication	Magazine
Author	Hermann Mallia (ed.)
Ref. Details	Mallia, H. ed, 2019. A President's Legacy: Interview with H.E. Marie-Louise Coleiro Preca President of Malta. *VIDA*. Attard: Focused Knowledge Ltd.
Title	A Modern Building and Construction Regulation Framework for Malta
Publication	Public Consultation Paper
Author	Kamra tal-Periti (Chamber of Architects and Civil Engineers, Malta)
Ref. Details	Kamra tal-Periti, 2019. *A modern building and construction regulation framework for Malta: public consultation paper.* Gzira: Kamra tal-Periti